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NUMERICAL ABUNDANCE AS THE CRITERION FOR SUCCESSFUL SPECIES

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In introducing his discussion of this subject, Professor A. Franklin Shull says, "Even as late as the early years of the present century, a work canvassing the status of Darwinism at that time, referred to natural selection, on page after page as involving life-and-death distinctions. Conn, some years earlier, had pointed out the needlessness of this assumption, and occasionally others shared his view. But for a long time the prevailing assumption was that a character must save a life that would otherwise be destroyed, or destroy an individual which without that character could survive, if natural selection were to work." (1936, p. 152.)

It must be noted, nevertheless, that if the Darwinism theory is being adhered to, the view cited must be retained. Darwin says that "any variation in the least degree injurious would be rigidly destroyed" (?1912, p. 70); and that "A grain in the balance may determine which individuals shall live, and which shall die—which variety or species shall increase in number, and which shall decrease, or finally become extinct." (ibid., pp. 454–5.)

Shull goes on to inquire, "What should supplant this view? To answer this question it need only be recalled that success or failure depends on numbers" (1936, p. 152). "Numbers in whatever manner attained constitute the best assurance of permanence" (ibid., p. 153). "Even a very slight percentage increase, not necessarily occuring every generation but perhaps only occasionally, should suffice eventually to enable the favored type to supplant those less favored. It is clear, therefore, that natural selection need not render life-and-death decisions in order to work. Mere differential numbers suffice. Recognition of this fact alters somewhat the criticisms that may be leveled against it, and conclusions regarding what it can accomplish" (ibid., p. 154).

It is difficult to see why any effort should be made to retain the term "natural selection" since it is probably the most unfortunate that ever afflicted biological science. At any rate the thing that Shull is talking about is not Darwinian natural selection but numerical dominance. Darwin insisted upon numbers as the criterion of success in evolution but it was always numbers attained by mitigation of destruction (?1912, p. 59), by protection from predation or from other environmental checks (ibid., p. 94). The theory should not be warped away from its original form and still be represented as the same. This gives Darwin undue credit and proponents of the new view unjust advantage from his prestige.

The present criticism is not directed particularly against Shull—he merely furnishes quotable extracts good for a take-off. "The leaving of many descendants is recognized as the criterion of success" (1936, p. 212), he continues, and repeats "success in evolution depends on numbers" (ibid., p. 217).

The objections that can be urged against this point of view are numerous and weighty. In the first place it must not be forgotten that "natural control is necessary and inevitable. No species can go on increasing in numbers indefinitely." (Moss, 1933, p. 220.) In fact, self-limitation of populations is a widespread,

perhaps a universal, phenomenon (McAtee 1936). That would not be the case if numbers alone were necessary for "success."

Again, whether as a function of natural control, or not, the carrying capacity of the environment for any organism has an upper limit that apparently cannot be transgressed more than temporarily. There is in effect, therefore, regardless of its mechanism, what amounts to a direct limitation of numbers by environmental influences. Carrying capacity thus rather rigidly regulates populations and is far from leaving attainment of abundance as something to be achieved through merit of the intrinsic qualifications of an organism.

It is certainly worthy of note also that the "leaving of many descendants" is characteristic chiefly of species that manifest excessive reproductive effort a process that is almost invariably accompanied by a high percentage of failure. Call such species "successes" if you will, but face the question, Are species successful from an evolutionary or any other point of view when they must produce a thousand or more eggs, a million or more sperms for every individual brought to maturity? Under the selection principle of adaptation they must be regarded as very crudely adapted, and it is difficult to see how they can be esteemed as successful under any phase of natural selection doctrine with its fetish of "survival of the fittest."

As a theoretical consideration it may be pointed out that it is just those species with a low birth rate that would seem most likely to be moulded by the alleged perfecting influence of natural selection, for the reason that there would be less scope in their case for indiscriminate elimination of progeny. On these grounds, under the theory, the species most affected by natural selection, namely, the rare ones, would be the most successful Attainment of large numbers would hardly seem a "natural selection" phenomenon, anyway, as "natural selection" is exclusively a destructive or checking influence

One of Darwin's remarks upon the subject of numerous progeny is, "the real importance of a large number of eggs or seed is to make up for much destruction at some period of life." (?1912, p. 59.) Like many another statement, this gives natural selection on anticipatory effect which, of course, it could not have. Destruction, moreover, is not a fixed toll but is more or less in proportion to production. If this were not the case, species would never recover from descending oscillations in numbers, although they regularly do.

If "success in evolution depends on numbers," how has it happened that organic populations have evolved, almost everyone of which undergoes profound fluctuations in numbers? One enthusiastic selectionist has asserted that "for an animal species in a state of nature, a declining population involves grave hazards." (Williams, 1932, p. 306.) If this be so, why has natural selection permitted fluctuation to be a characteristic of apparently all organic populations? Why does it allow all more or less regularly to decline in numbers?

In various well-known instances, fluctuations occur regularly at intervals of a decade or less. According to the numerical criterion of success, these species are successful at the crest of the population wave, unsuccessful at the trough. That the same species can be both successful and unsuccessful, evolutionarily speaking, and that too within ten or fewer years is another of the paradoxes to which selectionists are so hospitable.

As to fluctuations, if numbers were a guarantee of "success," populous species would not lose their abundance, and if numbers were necessary to "success," species could not regain them after a "low." The fact that both phenomena are of regular occurrence is another of the many evidences that "natural selection" is not in control.

One of the Darwinian tributes to numerical abundance is: "a large stock of individuals of the same species, relatively to the numbers of its enemies, is absolutely necessary for its preservation." (?1912, p. 62.). If numbers are so vitally important, it certainly is pertinent to inquire why the strictly utilitarian principle of

"natural selection" has permitted establishment of an almost universal feature of the cutting down of the numbers of all organic populations by an enormous percentage (90–99 or more) in every generation.

A fact overlooked in connection with the Darwinian edict quoted is that predation tends to be proportional to population (McAtee, 1932, 1934, 1935). Rarity, in itself, protects both by evading notice and by forcing enemies to turn their attention to more abundant sources of subsistence. The prey-predator, is just as important as the predâtor-prey, relationship. The enemies of cyclic species have a low immediately following that of their prey but in the transition period with prey scarce, predators not yet scarce, there is no indication of extermination; the last few of anything are hard to find.

When as in the predator-prey or parasite-host relationship, numbers of a species depend on those of one or more food or host organisms, they may fluctuate without regard to survival value of their own characteristics. More hosts, more prey, bring an increase in no way due to excellences of the dependent species. Such attainment of numerical abundance is not a result of survival of the fittest for "natural selection" of species (the dependents) cannot be based on the qualifications of other species (the supporters).

The very term numerical dominance implies the contemporaneous existence of less numerous, along with the more numerous, species. This is not only a fact of every-day observation but the fundamental phenomena of food-chains and other inter-organismal dependencies clearly demonstrate that it has always prevailed. The success of parasites and predators cannot be measured by numbers because the more numerous they are, the more they prejudice their own interests Consumers must be fewer in numbers (or less in bulk) than producers. This is a truism, an inexorable law, that has prevailed throughout the whole course of evolutionary history.

This fact alone proves that less numerous species have been just as successful as the more numerous. They have maintained existence in numbers appropriate to their ecological status and as permitted by the dominating principle of fluctuation. There have been rare, there have been common, there have been abundant, species in all states of evolution. The less common, so far as we can judge from paleontological evidence, have been no more prone to extinction that the more common. Among the latter, some Brachiopods, for instance, were so abundant that the shells of the dying formed thick beds of limestone. The same is true of certain Crinoids, while some Foraminifera have a similar relation to chalk. Some of the plants that were the basis of coal deposits must have been very abundant. All of these organisms and many more, that could be named, once were very numerous but now are totally extinct. Their history amply refutes the dictum that "success in evolution depends on numbers."

Taxonomic investigations of large groups characteristically show that the wide-ranging and common, that is dominant, species are relatively few, while those of more restricted range and populations are relatively numerous. Ecological study generally confirms the principle stated by Raunkiaer that "the least frequent species are much the more numerous." (1934, p. 397.). An evolutionary theory based on dominants, therefore, ignores a large numerical preponderance of species. As all are the product of evolution and as all are concerned in whatever evolution is now occurring, the theory cited can hardly be regarded as satisfactory.

In logic, and in fact, a species, whether common or rare, is "successful" so long as it has a place in the sun. Since none forever maintains place, none is permanently successful. Evolution is not a record exclusively of "successes;" it is a story of the origin and rise, decline and extinction of all organisms, and withal is one so consistent that we can hardly suppose that there ever have been or ever will be any exceptions. If we read evolutionary history aright, there are, in the last analysis, no "successful" species, for all eventually disappear.

Darwinism is a theory of the transformation of organic forms by mass variation and "natural selection." The importance of numerical advantage is emphasized by iteration and reiteration but what has the theory to say of the less numerous and of the rare, that have undoubtedly been present at all stages of evolution? That they kept evolutionary pace with the more numerous species is demonstrated by their presence in every phylum today.

Despite the Darwinian "view of the necessity of a large stock of the same species for its preservation" (?1912, p. 62), all species could not have developed by transformation of existing abundant species, for in that case the total number of species evolved would have been relatively small instead of extremely high as is actually the case. It is not only natural to believe, but under the circumstances, it is a logical necessity to conclude, that many, probably most, species originate in small numbers. Darwin seemed to view rarity as "the precursor to extinction" (ibid., p. 94), but it would seem equally well regarded as the normal state of a new form. Willis defends this view in "Age and Area" and a distinguished geologist (R. H. Rastall) says "It may safely be assumed that any given species arises at a point, or within a very small area, and spreads outward by migration." (1929, p. 170.) On this eminently reasonable view, it must be concluded that, as a rule, species in their origin (and this is what Darwin was writing about) lacked the very thing, numbers, upon which success in evolution is said to depend.

De Vries, concurring with Willis, notes that, "all over the earth and in every systematical group of plants the rule prevails that the most wide-spread species are the oldest." (1918, p 630.) This principle of course applies to organisms only in the assurgent phases of their history but it makes numbers (before senescence) a function of the ages of organisms—quite a different thing from being the result of the "survival of the fittest."

This essay presents evidence along about a dozen different lines, all to the effect that success in evolution does not depend on numbers. Possession of great numbers is no guarantee of success, and lack of them no threat of failure. Whatever their relative average abundance, all organisms fluctuate in numbers. On the numerical criterion, all must, therefore, be classed as both successful and unsuccessful The latter label fits all in the end, for whatever their quondam prosperity, all at length becomes senescent and finally extinct.

LITERATURE CITED

Darwin, Charles. 1912?. The origin of species by means of natural selection or the preservation of favored races in the struggle for life. Reprint, 6th ed., xix+501 pp. Hurst & Co., New York, N. Y.

De Vries, Hugo. 1922. Age and area and the mutation theory. Chapt. XXI, pp. 222–227, in Willis, J. C., Age and area. A study in geographical distribution and origin of species. x+259 pp., figs. The University Press, Cambridge, England.

McAtee, W. L. 1932. Effectiveness in nature of the so-called protective adaptations in the animal kingdom, chiefly as illustrated by the food habits of nearctic birds. Smiths. Misc. Coll. 87(7), 201 pp., numerous tables.

1934. Protective resemblances in insects—experiment and theory. Sci. 79(2051) April: 361–363.

1935. Rejoinder to Dunn on "The survival value of specific characters." 4 pp., privately printed, Washington, D. C.

1936. The Malthusian principle in nature. Sci. Monthly 42(5), May: 444–456.

Moss, J. Eliot. 1933. The natural control of the cabbage caterpillars, *Pieris* spp. Journ. Animal Ecol. 2(2), Nov.: 210–231.

Ra.(stall), R. H. 1929. Geology. Encyclopaedia Brittannica, 14th ed., 10: 154–173, Pls. 1–2.

Raunkiaer, Christen. 1934. The life forms of plants and statistical plant geography. 632 pp., 189 figs., many tables. The Clarendon Press, Oxford, England.

Shull, A. Franklin. 1936. Evolution. x+312 pp., 64 figs. McGraw-Hill Book Co., Inc., New York, N. Y.

Williams, Henry Smith. 1932. Survival of the fittest. xxix+321 pp., illus. R. M. McBride & Co., New York, N. Y.

Willis, J. C. 1922. Age and area. A study in geographical distribution and origin of species. x+259 pp., figs. The University Press, Cambridge, England.

A REVIEW OF THE NORTH AMERICAN SPECIES OF TEXANANUS (HOMOPTERA—CICADELLIDAE) NORTH OF MEXICO

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The genus *Texananus* was established by Ball in 1918 and *Phlepsius* (*Texananus*) *mexicanus* was designated as the genotype. In characterizing this group Ball stated, ". . . with head narrower than pronotum, front rather broad, convex, widening above the antennae and approaching the eyes. Vertex bluntly conical, the margin to the front rounding. Pronotum large, broadly and evenly rounding in front; the lateral margin long, oblique and definitely carinate."

The species occurring in the United States have been described in various journals (partly as *Phlepsius*). An attempt has been made here to bring together all this material from various sources, illustrate the diagnostic characters of both sexes in so far as these are known, establish further synonomy and present a key for their separation. *T. areolatus* with its sharp margined vertex and genitalic structures seems to be distinct from the other species. A new subgenus *Aridanus* is suggested for it.

Certain groups of closely related species are found in this genus. The short robust species of the *ovatus* group are represented by *ovatus*, var. *distinctus*, *denticulus*, *bialtus*, *gladius*, *latipex*, *lathropi*, *delicatus*, *pergradus*—probably the same as *delicatus*—*sonorus* and *deversus*, a new species described below. Four species, *superbus*, *angus*, *vermiculatus* and *oregonus*, represent another small group. *T. excultus*, *dorothyae*, *incurvatus* and *neomexicanus* comprise another group of closely related species. A fourth group is composed of *graphicus*, *marmor*, *monticolus* and *cumulatus*, which are quite similar in form. *T. decorus* and *dolus* are similar and are closest in form to the *ovatus* group. *T. rufusculus* is rather distinct in type of genitalia. It is probably most closely related to *decorus*.

KEY TO SUBGENERA

1. Vertex convex above, sloping to margin which is thick although angled with the front.....Subgenus *Texananus*

1'. Vertex depressed on disc behind margin, definitely excavated, the margin sharp, foliaceous. The face is more flattened.....Subgenus *Aridanus*

Subgenus **Aridanus** nov.

This group is characterized by a vertex narrower than the pronotum and which is definitely depressed or excavated on the disc, margin of vertex sharply angled with front, thin and foliaceous. The aedeagus of the male is composed of a single process with a broad erect basal portion.

Genotype *Texananus areolatus* (Baker).

Texananus areolatus (Baker)

Phlepsius areolatus Baker. Can. Ent. 30: 30, 1898.

A broad, robust species, ivory white, tessellate with brown fuscous and black. Length 6 mm.

Vertex broad, about one-third longer on middle than next the eyes. Color—entire insect mottled or tessellate, anterior margin of vertex alternating with ivory and black spots. Irrorations of elytra often forming definite areolar spots.

Female seventh sternite with posterior margin broadly, shallowly emarginate; a short V-shaped notch at apex, a brown spot on either side. Male plates short, broad, rounded, almost semicircular. Aedeagus composed of a basal portion which is enlarged dorsally and produced, bearing a narrowed, anteriorly curved, dorsal process. A long ventral process is narrow and produced caudally. Pygofer short, broadly truncate posteriorly.

This species was originally described from specimens collected in Kansas. It is a typical prairie species and has been found only in areas of prairie in the central states, particularly those in the Mississippi and Missouri valleys.

Subgenus **Texananus** Ball.

The vertex margin is angled with the front but thickened. Vertex convex above, sloping to the margin.

KEY TO SPECIES OF SUBGENUS TEXANANUS

1. Ninth segment with a tubular ovipositor (female) 2
1'. Ninth segment without a tubular ovipositor, but with two triangular or rounded plates (male) 14
2. Median portion of seventh sternite produced beyond the posterior margin of the lateral angles 3
2'. Median portion of seventh sternite either excavated or notched, not as long as lateral margins 4
3. Posterior margin of seventh sternite roundedly produced from base to form a pair of median approximate rounded teeth ..... *rufusculus*
3'. Posterior margin of seventh sternite with four distinct teeth on median half. The outer tooth on each side separated from the inner pair by a rounded notch .... *denticulus*
4. Seventh sternite short, posterior margin concavely rounded, notch at middle appearing square with lateral margins parallel ..... *lathropi*
4'. Seventh sternite without parallel margined notch or, if U-shaped, without concave posterior margin 5
5. Posterior margin of seventh sternite broadly excavated without a median notch 6
5'. Posterior margin of seventh sternite either not broadly excavated or, if so excavated, with a median notch 10
6. Lateral portions of preceding sternite conspicuous at lateral margins or along posterior lateral margin of excavation of seventh sternite 7
6'. Without visible lateral portions of preceding sternite in excavated portion of seventh sternite 9
7. Lateral portions of sixth sternite decidedly produced on posterior lateral margin of seventh sternite ..... *dorothyae*
7'. Visible lateral portions of sixth sternite smaller, less conspicuous, usually not produced posteriorly 8
8. Seventh sternite long with a rather deep and more narrowed excavation .... *neomexicanus*
8'. Seventh sternite shorter, more broadly excavated ..... *incurvatus, excultus*
9. Seventh sternite broadly roundedly notched almost to base ..... *vermiculatus*
9'. Seventh sternite with shallow excavation reaching not more than half way to base, *superbus, angus, oregonus*
10. Posterior margin of seventh sternite with a deep, rather broad, V-shaped notch at the base of which on either side is a distinct rounded notch. The V-shaped median notch separated from the lateral rounded notches by a distinct tooth 11
10'. Median notch broad and shallow or with rounded apex 12
11. Posterior margin of seventh sternite rounding from base without distinct lateral angles ..... *cumulatus, graphicus*
11'. Posterior margin of seventh sternite with more distinct lateral angles .. *monticolus, marmor*
12. Seventh sternite with definite produced lateral angles 13
12'. Lateral margins of seventh sternite rounded from base to produced posterior margin—without lateral angles ..... *decorus, dolus*
13. Seventh sternite short, median notch shallow, very narrow at apex, *ovatus, pergradus, latipex, distinctus*
13'. Seventh sternite rather long, lateral angles strongly produced, broadly rounded. Median notch extending more than half way to base, notch U-shaped, broad at apex .... *sonorus*
14. The aedeagus with a basal portion, dorsally produced and connected to ventral portion by a narrow, usually elongated process 18

14'. The aedeagus consisting of one process or with the basal portion broadly attached to body of aedeagus 15
15. Pygofer almost twice as long as plates ..... *neomexicanus*
15'. Pygofer shorter than or not more than one-half longer than plates 16
16. Pygofer shorter than plates ..... *dorothyae*
16'. Pygofer longer than plates 17
17. Aedeagus conspicuously thicker on base and at middle than apical portion; pygofer slightly exceeding plates ..... *excultus*
17'. Aedeagus tapered at base and at apex, slightly broadened at point of attachment to connective; pygofer exceeding plates by about one-half their length ..... *incurvatus*
18. The ventral portion of the aedeagus composed of a pair of divergent processes, the dorsal portion single 19
18'. The ventral and dorsal portions of the aedeagus each composed of a single process 22
19. Ventral aedeagus processes blunt at apex, enlarged by dorsal and ventral finger-like processes ..... *oregonus*
19'. Ventral aedeagus processes elongate, slender at apex 21
20. Ventral processes long, curved with a branched portion arising at about half their length ..... *vermiculatus*
20'. Ventral processes shorter, straight, or slightly curved at apex 21
21. Male plates short and broadly rounded, greatly exceeded in length by pygofers ..... *superbus*
21'. Male plates triangular, bluntly pointed at apices, almost as long as pygofers ..... *rufusculus*
22. Ventral portion of aedeagus straight, pointed on ventral margin at apex with a pair of pointed teeth on dorsal margin just before apex ..... *ovatus* & var. *distinctus*
22'. Ventral portion of aedeagus bent or, if straight, without teeth or other projections 23
23. Ventral portion of aedeagus bent abruptly ventrally then narrowed and pointed at apex ..... *deversus*
23'. Ventral portion of aedeagus not bent abruptly near apex 24
24. Dorsal aedeagus with the apex bifid ..... *latipex*
24'. Dorsal aedeagus curved to form a pointed apex 25
25. Ventral portion of aedeagus slender from base to apex, not exceeding dorsal portion in length ..... *pergrada*
25'. Ventral portion of aedeagus broader or, if slender, longer than dorsal portion or both 26
26. Styles notched at apex, the outer margins produced and pointed ..... *lathropi*
26'. Styles not notched at apex 27
27. Ventral portion of aedeagus broad at base, tapered, narrowed to pointed apex 28
27'. Ventral portion of aedeagus not tapered from base to apex 30
28. Base of dorsal aedeagus portion broadened and thickened 29
28'. Base of dorsal aedeagus portion more narrowed ..... *denticulus*
29. Thickened basal portion of dorsal aedeagus produced so as to leave only a small opening between projected portion and apex ..... *bialtus*
29'. Thickened portion of dorsal aedeagus not strongly produced, opening between projection and apex broad ..... *sonorus*
30. Ventral aedeagus broadened and blade-like either throughout or near middle 31
30l. Ventral aedeagus about the same width throughout, not blade-like 35
31. Ventral aedeagus blade-like or broadened to near apex 32
31'. Ventral aedeagus broadened near middle or on apical half 33
32. Ventral aedeagus distinctly longer than pygofer, curved upward toward apex, plates short, blunt, rounded ..... *gladius*
32'. Ventral aedeagus scarcely exceeding pygofer, slightly curved downward toward apex; plates longer, more produced, blunt at apex ..... *dolus*
33. Ventral aedeagus enlarged at about middle, dorsal aedeagus scarcely enlarged at base ..... *decorus*
33.' Ventral aedeagus enlarged on apical portion just before apex, dorsal aedeagus decidedly thickened on basal half 34
34. Styles short, blunt, apical portion broad, slightly produced on outer margin ..... *marmor*

34'. Styles elongate, apical half narrowed and produced, apices narrow, blunt.....*graphicus*
35. Ventral aedeagus curved upward at apex, dorsal aedeagus elongated; plates short, rounded, greatly exceeded by pygofers.....*monticolus*
35'. Ventral aedeagus more slender, straight, dorsal aedeagus shorter, thicker at base; plates more elongate, blunt at apex, exceeded less by pygofers.....*cumulatus*

Texananus rufusculus (Osborn & Lathrop)

Phlepsius rufusculus Osb. & Lath. Anns. Ent. Soc. Amer. 16: 340, 1923.

A rather large robust reddish brown species resembling *superbus* in general form. Length 7–7.25 mm.

Vertex one-fourth longer on middle than next the eyes. Color yellowish with reddish brown irrorations, anterior border of vertex ivory yellow.

Female seventh sternite broadly, roundedly produced from base to a pair of short, broadly rounded teeth separated by a narrow notch. Male plates rather long, triangular, with bluntly pointed apices. Aedeagus with a pair of ventral lateral processes which are divergent, and a median process which is enlarged at the base, abruptly tapered to a long, slender, tapering process.

Originally described from Ohio and Missouri, it has since been collected in southern Illinois. It has been collected only in moist woodland or wooded floodplain areas on rank growing herbaceous vegetation.

Texananus neomexicanus (Baker)

Phlepsius neomexicanus Baker. Psyche 7: 13, 1895.

Related to *excultus* and *incurvatus* but with a much longer pygofer. Length 7–8 mm.

Vertex produced and bluntly angled, almost two-thirds as long at middle as basal width between the eyes.

Color: Pale with few dark markings on vertex, pronotum and scutellum. Elytra with brown veins and rather heavily marked with brown pigment lines.

Genitalia: Female seventh sternite with broad, prominently produced lateral angles between which the posterior margin is broadly, deeply, concavely excavated almost to base. Portions of the preceding segment are visible at either side. Male plates rather long, apical half tapered to pointed apices. Style rather broad, the apex with a curved finger-like process arising on inner margin, curved outwardly. Aedeagus attached to connective at about its middle. The median portion broadened. The basal portion narrowed and extending dorsally, the apical third narrowed, recurved on basal portion and tapered to a slender apex. The pygofer is extremely long, almost twice as long as plates.

This was described from New Mexico and is found only in the southwestern states.

Texananus excultus (Uhler)

Jassus excultus Uhler. Bull. U. S. Geol. & Geog. Surv. 3, 467, 1877.

Related to and resembling *superbus* in general form and size. Length 6–6.5 mm.

Vertex about one-fourth longer on middle than next the eyes. In color the vertex, pronotum and scutellum are tawny yellow, the elytra are darker brownish.

Female seventh sternite broadly excavated two-thirds the distance to base. Not far from the lateral margins on each side, the sides of the sloping lateral margin are slightly produced and rounded. Portions of the underlying segment are exposed at the sides of the excavation. Male plates broad, triangular, apices bluntly pointed. Aedeagus with a basal, dorsally produced process which is tapered and bluntly pointed dorsally. Apical portion narrowed, tapered to a slender pointed apex which is curved dorsally and anteriorly, almost touching the basal portion. Pygofers short and pointed, not exceeding plates.

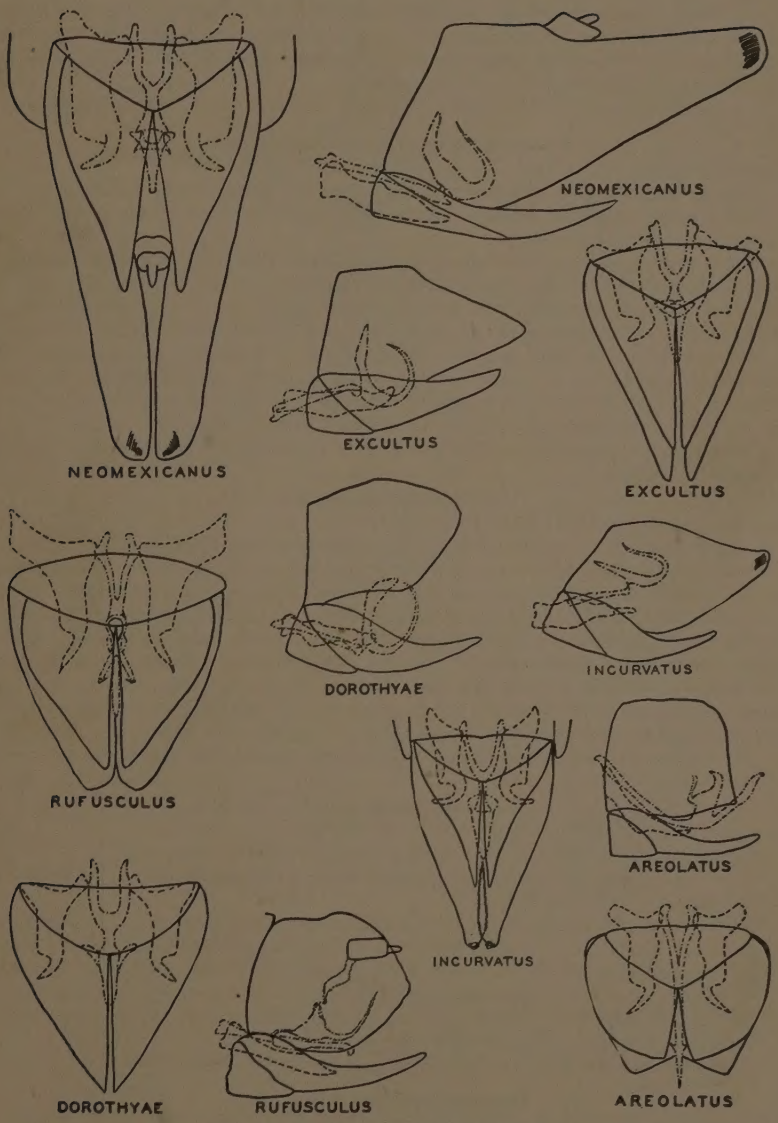
Originally described from the southern states, it occurs throughout the eastern and central states.

Texananus dorothyae DeLong

Texananus dorothyae DeLong. Anal. Esc. Nac. de Cien. Biol. 1: 387, 1939.

Related to *excultus* and *incurvatus*. Length 6.5 mm.

Vertex bluntly angled, almost one-half longer at middle than next the eyes, less than twice as wide between eyes as median length. Color yellowish with pale brownish markings.



Lateral and ventral views of male genitalia of species of *Texananus* as named.

Female seventh sternite short, broadly concavely excavated almost to base; the lateral portions of the underlying segment conspicuous for their entire width beyond the seventh sternite. Male plates rather broad, triangular, apices pointed. Plates as long as or exceeding pygofers, which are bluntly produced and rounded at apex. Aedeagus similar to *excultus*, U-shaped with the dorsal ends curved inwardly, sometimes proximal. The basal, dorsal end is broadest, gradually tapered to a slender pointed apex.

It occurs in the southwestern states. The types are from Texas, Arizona and Mexico.

Texananus incurvatus (Osborn & Lathrop)

Phlepsius incurvatus Osb. & Lath. Anns. Ent. Soc. Amer. 16: 346, 1923.

A species with the head distinctly angulate, related to *neomexicanus*. Length 5.5–5.7 mm.

Vertex a little wider than length at middle, nearly twice as long at middle as next the eyes. Color gray, irrorate with fuscous.

Female seventh sternite rather short, broadly, deeply, roundedly excavated almost to the base. The lateral portions of the preceding segment visible at either side of the excavation. Male plates elongate, triangular, with acutely pointed apices, about two-thirds as long as the pygofer. The style is rather short and broad with an outwardly curved finger-like process at apex originating on the inner margin. The aedeagus is U-shaped. As compared to *neomexicanus*, the portion of the aedeagus is more narrowed at the point of contact with the connective than in *neomexicanus*. In *incurvatus* the pygofer exceeds the plates by about one-half their length, in *neomexicanus* the pygofer exceeds the plates by about their length.

This species was originally described from Arizona specimens. It occurs in the southwestern United States and Mexico.

Texananus oregonus Ball

Texananus oregonus Ball. Pan-Pac. Ent. 8: 85, 1931.

Related to *superbus* but with distinct male genital structures. Length 6.5 mm.

Vertex bluntly angled, about two-thirds as long at middle as basal width between the eyes. Color brown with black markings at ends of claval veins along posterior margins of elytra.

Female seventh sternite with lateral margins sloping to posterior margin which is broadly, rather shallowly excavated, less than half the distance to the base. Male plates short and broad, together semicircular in shape, exceeded in length by the pygofers. The dorsal median process of the aedeagus is broad at base, narrowed, and curved apically. The two ventral, lateral processes are broadened dorsoventrally and in lateral view are broadened at the apex and notched producing fingerlike processes which extend dorsally, ventrally and caudally.

This species was originally described from Oregon, Washington and California and has since been taken in Arizona.

Texananus vermiculatus DeLong

Texananus vermiculatus DeL. Ohio Jour. Sci. 38: 42, 1938.

Related to *superbus* which it resembles in general appearance. Length 6 mm.

The vertex is blunt, almost twice as wide between eyes as the median length. Color yellowish with brownish and black markings.

The female seventh sternite is deeply and rather sharply excavated almost to base, forming a broad V-shaped notch with the apex widened. Male plates short and broad, broadly rounded, together appearing semicircular in shape. The aedeagus with three processes. The median portion is short, enlarged at base and curved dorsally. The two lateral processes are long, slender, curved dorsally then ventrally at apex. A short branched process arises at about one-third the distance to apex. The pygofer is long and blunt at apex.

This species was described from specimens collected in Arizona and Texas.

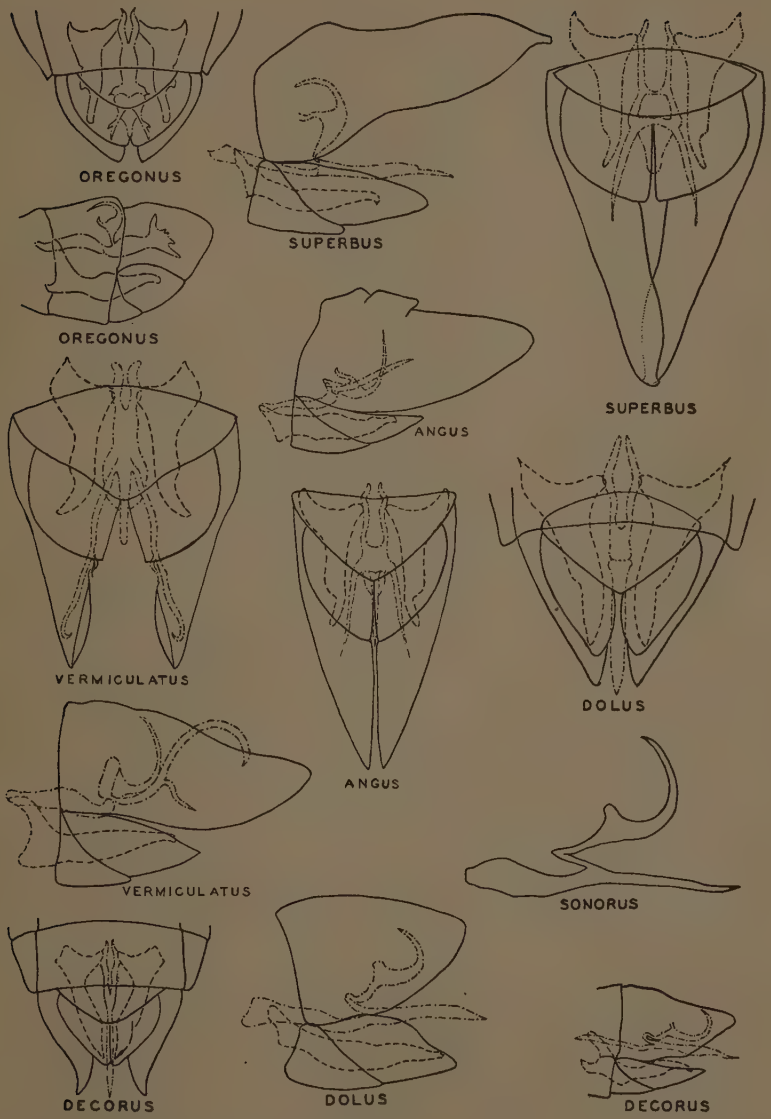
Texananus superbus (Van Duzee)

Phlepsius superbus Van Duzee. Trans. Amer. Ent. Soc. 19: 81, 1892.

This species is broad, narrow headed and robust. Length 6 mm.

Vertex roundedly angulate, about two-thirds longer on middle than next the eyes. Color pale brown irrorate with black and dark brown.

The female seventh sternite is broadly excavated half way to the base. The apex of emargi-



Lateral and ventral views of male genitalia of species of *Texananus* as named except *sonorus* which is lateral view of aedeagus only.

nation occupying about one-third of the entire width between the lateral angles is truncate. Male plates short, broad, together semicircular. Aedeagus with a pair of long ventral processes which are abruptly narrowed on dorsal margin near apex and produced in narrow pointed apices. Dorsal process short, sickle-shaped, with the curved apex directed dorsally and anteriorly. Pygofer long, tapered, concavely narrowed on ventral margin to a rather pointed apex.

Originally described from specimens from North Carolina and Arizona, it is a rather widely distributed species occurring throughout the southern United States and in several of the more northern states it occurs on grasses in meadows and pastures.

Texananus angus DeLong

Texananus angus DeLong. Ohio Jour. Sci. 38: 42, 1938.

Related to *superbus* and the Mexican species *curtus* but with distinct male genital characters. Length 6–6.5 mm.

Vertex bluntly angled, about one-third longer at middle than length next the eyes. Color brownish with darker brown markings.

Female seventh sternite broadly, angularly excavated more than half way to base; the apex of excavation rounded. Male plates broad, rather short and bluntly pointed, almost rounded, at apex. Aedeagus with three processes as in *superbus*, a pair of straight processes between which is a median portion with an enlarged base and an elongate slender apical two-thirds which is curved upward. The pygofer is elongate and blunt at apex, about twice as long as plates, but shorter than *superbus*.

Described from specimens collected in Texas, Oklahoma and Kansas.

Texananus decorus (Osborn & Ball)

Phlepsius decorus Osb. & Ball. Proc. Ia. Acad. Sci. 4: 230, 1897.

A rather short, robust species with flaring elytra. Length 6 mm.

Vertex broadly, roundedly angulate, about one-third longer on middle than against the eyes. Color white marked with tawny, a transverse pale band on vertex. Elytral commissural line on clavus with ivory white lobate spots.

Female seventh sternite with lateral margins rounded to posterior margin which is almost truncate; median third broadly, deeply excavated, with a broad, but not rounded, apex at the middle extending two-thirds the distance to the base. Male plates short and narrow, triangular apices roundedly angled. Aedeagus with a long, slender, blade-like ventral process and a rather long, slender, dorsal process with apical third curved dorsally.

Originally described from Nebraska and Iowa, it occurs commonly in grassy areas throughout the United States and the Mississippi and Missouri valleys.

Texananus dolus DeLong

Texananus dolus DeLong. Pan-Pac. Ent. 14: 186, 1938.

Related to *decorus* but with longer male plates and a broader aedeagus. Length 6.5 mm.

Vertex broadly rounded, about twice as broad between eyes as median length. Color white marked with brown. Elytra with a pale margin and spots along commissural line.

Female seventh sternite short, almost truncate, posterior margin with a V-shaped median notch about two-thirds the distance to base. A small notch on side walls of median notch either side is rounded to posterior margin. Male plates triangular and slightly divergent, apices bluntly rounded. Aedeagus in lateral view with a rather broad ventral portion which is pointed at apex on lower margin, the dorsal sloping to ventral margin; dorsal portion twice curved, the apical portion sickle-shaped, apical half tapered and pointed, curved dorsally and anteriorly.

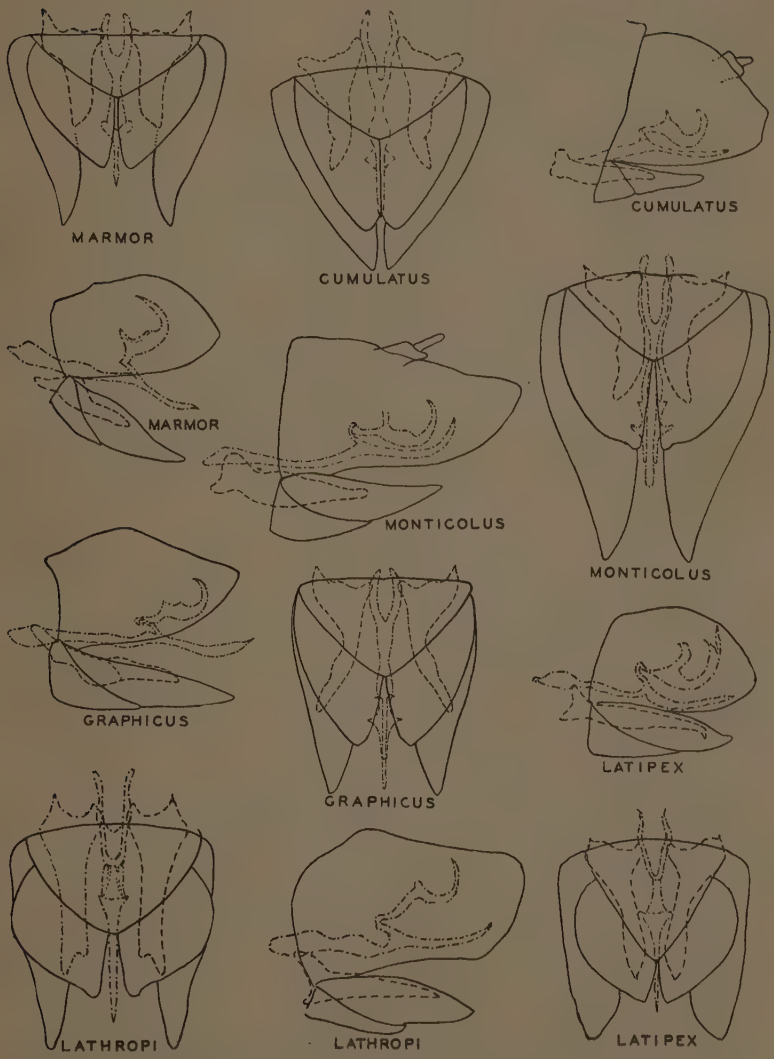
This species was originally described from Utah and has been taken only in the Rocky Mountain region.

Texananus sonorus (Ball)

Texananus sonorus Ball. Bull. Brook. Ent. Soc. 31: 19, 1936.

Related to *denticulus* which it closely resembles in type of male genitalia. Length, female, 6 mm.

In coloration it is rather distinct with a pale, conspicuous commissure with the vermiculate lines fine and more numerous along the white commissure. The female seventh sternite is rather



Lateral and ventral views of male genitalia of species of *Texananus* as named.

long with a rather broad U-shaped notch reaching more than half way to the base. The lateral angles are produced and rounded or bluntly angled. The male plates are broad and short, together appearing semicircular. The aedeagus is composed of two portions. The dorsal portion is sickle-shaped with a rather large base. The ventral portion is almost straight, tapered from base and narrowed to form a pointed apex.

The type specimens in the Ball Collection in the U. S. National Museum have been examined and the accompanying illustrations made from the types.

Texananus ovatus (Van Duzee)

Phlepsius ovatus Van Duzee. Trans. Amer. Ent. Soc. 19: 79, 1892.

A small species, broad, short, ovate with a rather uniform brownish color. Length 5 mm.

Vertex bluntly angled, median length one-third to one-half greater than next the eyes. Color dull yellowish with brownish irrorations.

Female seventh sternite with lateral angles rather prominent between which the posterior margin is broadly, rather shallowly excavated. At the apex of the excavation is a small V-shaped notch. Male plates quite short, broadly rounded, broader than long and decidedly exceeded by the pygofers. The inner margins of the plates are divergent. Styles long, the apical two-thirds is narrow and rather broadly, bluntly rounded at the apex. The ventral portion of the aedeagus is straight, and rather heavy, sharply pointed on the ventral caudal margin and with a pair of pointed spines or teeth on the dorsal margin at the point where it begins to slope to the ventral apical pointed tip. The dorsal portion is concavely rounded on the dorsal margin either side of a median, broad, slightly produced tooth. The median portion just beyond tooth thickened; the apex is narrowed to a slender sharp pointed tip which is curved strongly dorsally and anteriorly.

This species was described from specimens collected in Texas and is known to occur only in the southwestern states.

Texananus ovatus var. **distinctus** (Lathrop)

Phlepsius distinctus Lathrop. Ohio Jour. Sci. 17: 129, 1916.

The coloration is conspicuous, being ivory white marked with black or dark brown. The elytra are ivory white with dark markings.

Although slightly larger than *ovatus* and with a striking color pattern this form cannot be separated from *ovatus*, having identical male genitalia. In view of the color pattern it has been placed as a varietal form under *ovatus*.

All the specimens that have been observed have been collected in the southeastern portion of the United States.

Texananus bialtus DeLong

Texananus bialtus DeLong. Pan. Pac. Ent. 14: 185, 1938.

Closely related to *latipex* and *pergrada*. Length 6.5 mm.

The vertex is bluntly angled, about two-thirds as long at the middle as the basal width between the eyes. The color is dull yellow with dark brown markings, the elytra are creamy white rather sparsely marked.

The male plates are short, together almost semicircularly rounded. Styles broad at base, the apical two-thirds elongate and slender, blunt at apex, pointed on the inner margin. The ventral portion of the aedeagus in lateral view is broadened at the base and tapers to a slender pointed apex. The dorsal portion is sickle-shaped with the base thickened and broadened. The apical half is slender and tapers to a sharp pointed apex.

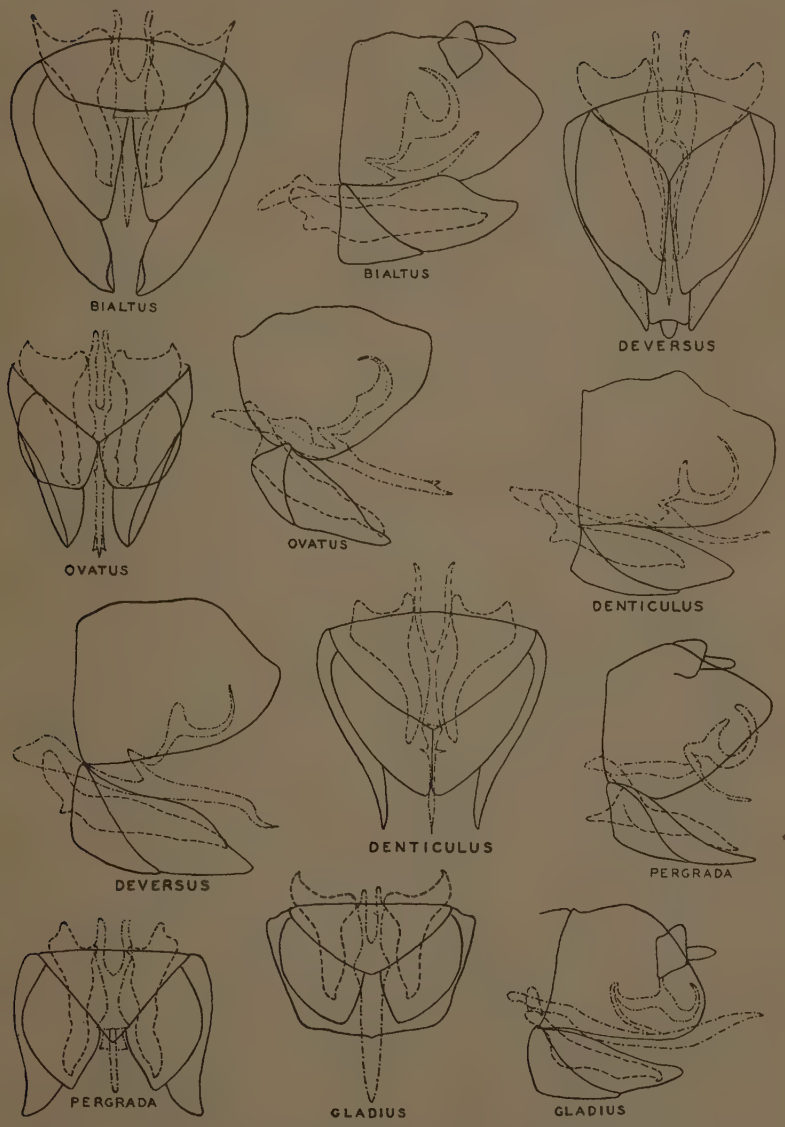
This species was described from material collected in the Davis Mountains of Texas.

Texananus deversus n. sp.

In form, appearance and coloration resembling *ovatus* but slightly larger and with distinct genitalia. Length, male, 5.5 mm.; female, 5 mm.

Vertex blunt, scarcely angled, more than half as long at middle as basal width between the eyes.

Color: Appearing pale brown, gray with ramose brown pigment lines. Vertex with a pale brownish triangular spot just above and either side of apex. A minute black spot just above each ocellus. The basal half of apex rather heavily marked with brownish irrorations. Pronotum



Lateral and ventral views of male genitalia of species of *Texananus* as named.

rather heavily marked with brown. Scutellum pale with three small black dots on central portion, two just back of margin of scutellum. Elytra with a pale border along scutellum and a pale commissural lobate area.

Genitalia: The female seventh sternite short, lateral angles rounded, posterior margin broadly concavely angularly excavated from lateral angles to a short median V-shaped notch which extends almost to the base. Male plates short, two-thirds as broad as long, apices bluntly pointed. Styles long and narrow, apices blunt. Dorsal portion of aedeagus with terminal portion sickle-shaped curved upward. Ventral portion elongated, extending caudally with apex curved downwardly, then apically, narrowed and sharply pointed.

Holotype male, allotype female and female paratypes collected at Brownsville, Texas, May 25, 1939, by D. J. and J. N. Knull.

Texananus denticulatus (Osborn and Lathrop)

Phlepsius denticulatus Osb. & Lath. Anns. Ent. Soc. Amer. 16: 345, 1923.

A small species resembling *ovatus*, but smaller. Length 4.25 to 4.75 mm.

The vertex is distinctly angulate but blunt at apex, nearly twice as long at middle as length next the eyes. Dull gray to pale brownish marked with darker brownish irrorations.

The female seventh sternite is produced to form blunt but prominent lateral angles. The posterior margin is rather deeply, roundedly excavated between the lateral angles and the median produced half which is notched so as to form four median produced teeth. The outer two are a little longer and more separated than the central pair. Male plates short, rather blunt and rounded at apex. Style elongate, basal half much broader than the apical half. The aedeagus is composed of two portions. The ventral part is rather broad at base and gradually tapers to a narrow, pointed, caudally directed apex. The dorsal portion is sickle-shaped, open upward The basal dorsally directed part is short and thick; the apical portion is narrow and curved.

The species was described from specimens from Los Banos, California.

Texananus gladius DeLong

Texananus gladius DeLong. Ohio Jour. Sci. 38, 41, 1938.

Closely related to *ovatus*. Length 5 mm.

The vertex is bluntly angled, two-thirds as long on middle as width between the eyes at the base. Color dull yellowish with dark brown markings and with pale commissural line.

The female seventh sternite is broadly, shallowly excavated with a short V-shaped notch at the center. The male plates are broader than long, broadly rounded. The ventral process of the aedeagus in lateral view is blade-like, protruding beyond the apex of the abdomen, bent upward and narrowed on the apical portion. The dorsal portion is connected to the ventral portion by a long, narrow strip. The dorsal portion is curved twice concavely upward. The basal portion is broadly, shallowly concave; the apical portion is more deeply concave with a slender apical portion which is curved caudally.

This species was described from specimens from Arizona and Texas.

Texananus delicatus (Osborn & Lathrop)

Phlepsius delicatus Osb. & Lath. Anns. Ent. Soc. Amer. 16: 347, 1928.

Resembling *ovatus* in form and general appearance. Length 5 mm.

The vertex is broadly, bluntly angled. The color is pale gray or brown with darker irrorations.

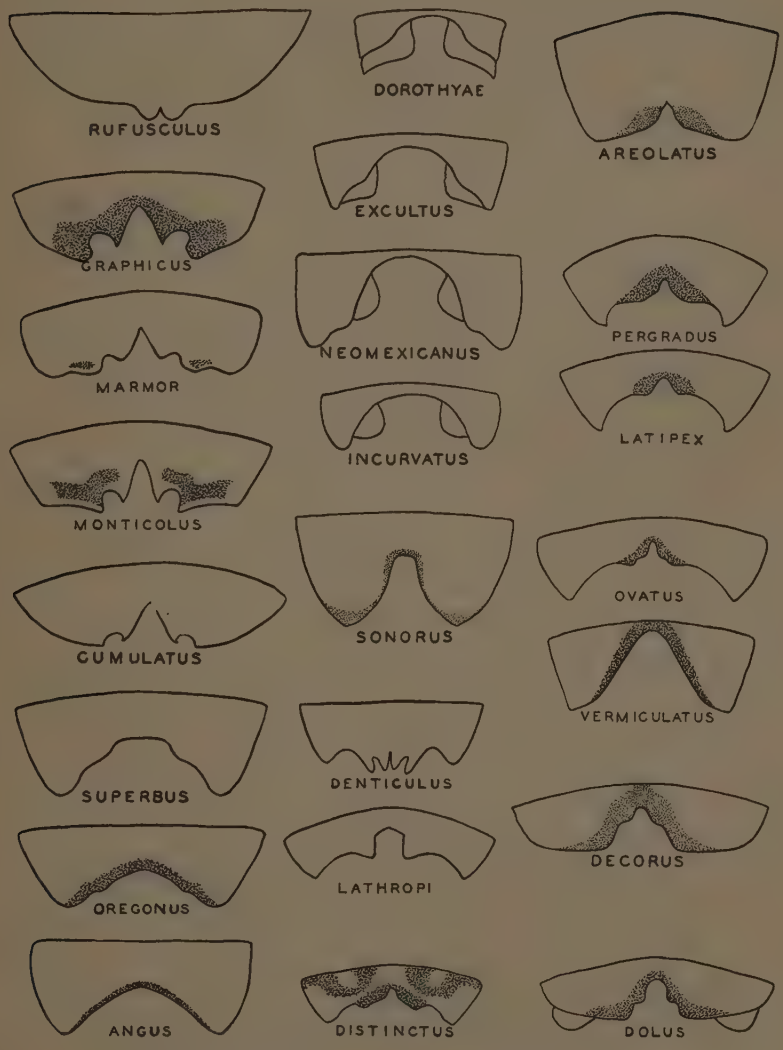
The female seventh sternite is short, the posterior margin is broadly, concavely excavated. Lateral angles produced and prominent.

This species was described from a single female specimen collected at Palm Springs, California. In view of the similarity of the females of this group of small species it has not been possible to definitely determine the identity of the male. It is quite probable that *pergradus* is a synonym of *delicatus*.

Texananus pergradus DeLong

Texananus pergradus DeL. Pan-Pac. Ent. 14: 185, 1938.

Resembling *ovatus* and closely related to it. The ventral process of the aedeagus is slender and unbranched. Length 4.5 to 5.5 mm.



Seventh sternite of females of species of *Texananus* as named.

The vertex is bluntly angled about two-thirds as long at middle as the basal width between the eyes. Color pale brown with darker brown markings. In well marked specimens with a broken brown band between the eyes on the disc. The three pale commissural spots on elytra distinct.

The female seventh sternite with prominent lateral angles between which the posterior margin is rather strongly and broadly excavated, with a short, brown margined, V-shaped notch at apex of excavation. Male plates broad and short, together appearing semicircular. Styles elongate, broadened at base, constricted near middle with apex bluntly pointed. The ventral portion of the aedeagus is very slender and delicate and is rather short. The dorsal portion is sickle-shaped, the base of which is thickened; the apex of which is more slender and strongly curved dorsally and anteriorly.

The type specimens of this species are from New Mexico, Texas and Utah. Its distribution is through the southwestern states.

Texananus latipex DeLong

Texananus latipex DeLong. Bull. Brook. Ent. Soc. 38: 124, 1943.

Related to *ovatus* and *lathropi* but with distinct genital structures. Length 6 mm.

The vertex is bluntly angled and almost twice as wide between the eyes at the base as its median length. The color is pale brown with dark brown markings. Elytra heavily marked with dark brown, the three pale commissural spots distinct.

Female seventh sternite with posterior margin rather deeply, broadly excavated between the prominent lateral angles. Male plates short with blunt apices. The styles are elongate, rather slender, broadened at base, constricted at middle, bluntly pointed at apex. The ventral portion of the aedeagus is rather long and slender, tapered to an acute tip. Dorsal portion broad at base with a dorsally curved basal process and a long curved sickle-like apical portion which is bifid at apex forming two prominent teeth.

This is a rather common and widespread species in the western United States. Specimens in the type series are from Arizona, Idaho, and Nevada. It has since been reported for California.

Texananus lathropi (Baker)

Phlepsius lathropi Baker. Phil. Jour. Sci. 27: 159, 1925.

Phelpsius annulatus Osborn & Lathrop. Anns. Ent. Soc. Amer. 16: 342, 1923 (homonym).

A small species belonging to the *ovatus* group. Length 5–5.5 mm.

Vertex blunt, a little longer on the middle than length next the eyes. The vertex, pronotum and scutellum are yellowish with brown irrorations. The elytra are white or pale with dark irrorations and dark pigment lines.

The female seventh sternite is quite short. The lateral angles are prominent, produced, between which the posterior margin is broadly, shallowly excavated with a deep quadrangular excavation more than half way to the base at the middle. The male plates are very short and broad, slightly bluntly produced at the apex. Styles rather narrow, slightly enlarged at base. Apex appearing notched at middle with a short, blunt, produced tooth on inner margin and a more produced blunt process on outer margin. The basal portion of the aedeagus is straight and rather slender, slightly enlarged at base. The dorsal portion is sickle-shaped with a long basal handle-like process.

This species was described from Oregon.

Texananus marmor (Sanders & DeLong)

Phlepsius marmor Sand. & DeL. Proc. Ent. Soc. Wash. 25: 152, 1923.

Resembling *graphicus* in general appearance but more conspicuously marked and easily separated by the shorter, broader male styles. Length 5.5–6 mm.

Vertex roundedly produced, two and one-half times as wide as long. Elytra short and broad.

Color: Dirty white, vertex with fuscous mottling near the apex and a pair of darker spots at base near eyes. Pronotum with anterior margin marked with dark brown, posterior portion unmarked. Elytra pale with faint markings giving a mottled appearance.

Genitalia: Female seventh sternite similar to *graphicus*. The lateral angles are more produced and rounded. The posterior margin is angularly excavated on the median half so as to form a median broad V-shaped notch and a smaller rounded notch on either side between this and posterior margin. The male plates are short and broad, bluntly pointed at apex. The styles are short, broad at base and while narrowed are rather broad at apex which is bluntly pointed on the outer margin. The ventral portion of the aedeagus is shorter and more narrowed than *graphicus*. The dorsal portion is sickle-shaped with the ventral portion broad or thickened, the apical half slender.

This species was described from specimens collected at Onah, Manitoba, July 24, 1919, from *Juniperus horizontalis*. It has not been recorded for other localities.

Texananus cumulatus (Ball)

Phlepsius cumulatus Ball. Can. Ent. 32: 202, 1900.
Phlepsius notatipes Osb. & Lath. Anns. Ent. Soc. Amer. 16: 343, 1923.

A very short, broad species with the vertex scarcely longer at middle than at the eyes. Length 6–6.5 mm.

The color is dark brown or reddish brown due to numerous irrorations and reticulations.

The female seventh sternite is roundedly produced from base to a narrow, rather shallow, emargination either side of a broad V-shaped notch which extends half way to base. Male plates broad, short, triangular with bluntly pointed apices; aedeagus with a rather long, slender ventral process and a dorsal process which is rather broad at base, narrowed apically and curved dorsally. Pygofers short and with apices bluntly rounded.

This species was described from Colorado. It has been collected in several of the western states and occurs on bearberry, *Arctostaphylus*, where this plant is growing on sandy areas along the Great Lakes.

Texananus graphicus (Ball)

Phlepsius graphicus Ball. Can. Ent. 32: 201, 1900.

Similar to *cumulatus* in general form and appearance. Length 7 mm.

Vertex broad, scarcely longer at middle than length next the eyes. Color dull straw yellow with brownish irrorations. The pale commissural line on elytra distinct.

Female seventh sternite long, lateral margins sloping to posterior margin which is deeply, roundedly excavated either side of a deep V-shaped median notch. These form a sharp pointed tooth on each side of notch and a blunt tooth on edge of anterior margin at each side. Male plates short, bluntly pointed on apices. Styles long, broad at base, the apical half quite narrow. Aedeagus with the ventral portion narrow, blade-like with the apex pointed. The dorsal process narrow at base, thickened on middle half, narrowed on apical third and curved dorsally. The pygofer is bluntly angled at apex.

It was described from Colorado and Nebraska.

Texananus monticolus DeLong

Texananus monticolus DeLong. Bull. Brook. Ent. Soc. 38: 125, 1943.

Related to *cumulatus* but with different genital characters. Length 6.5 mm.

Vertex more than twice as wide at base as median length, broadly, bluntly angled. Elytra short and broad. Color pale yellowish marked with brown.

Female seventh sternite similar to *graphicus* but the lateral angles are more produced. The posterior margin is excavated by three notches. The median notch is broadly V-shaped extending more than half way to the base, on either side of which is a rounded notch next posterior margin. Male plates strongly convexly rounded, apices blunt and rounded, inner margins straight to the apices. Styles elongate, rather broad, with blunt apices. Aedeagus with the dorsal process elongate, apex narrowed and curved dorsally, enlarged at middle. The dorsal portion appears to lie in the concavity of the long slender ventral portion which curves dorsally caudally to the dorsal portion.

Originally described from specimens collected in New Mexico and Utah.

A STUDY OF THE PROPORTIONS OF MALE AND FEMALE MOSQUITOES IMMEDIATELY AFTER EMERGENCE

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Western Reserve University,
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During the recent war, while the author was doing malaria survey work in Assam, India, some problems were studied using culicines which were so extremely abundant. A filthy open-sewer flowed directly through the village of Dibrugarh in Upper Assam, and served as the breeding place of millions of adult mosquitoes which swarmed through the huts during the night.

Almost all of these were of the species *Culex* (*Culex*) *fatigans* Wiedemann 1828 but a few *Aedes* (*Stegomyia*) *albopictus* Skuse 1894 were collected. The question naturally arose as to whether or not the adults emerged in greater numbers during the evening than they did at other times, and what the proportions at various times were of males and females.

Because of obvious restrictions during war time, traps could not be set over the breeding places in the village which would have been an ideal method, but instead

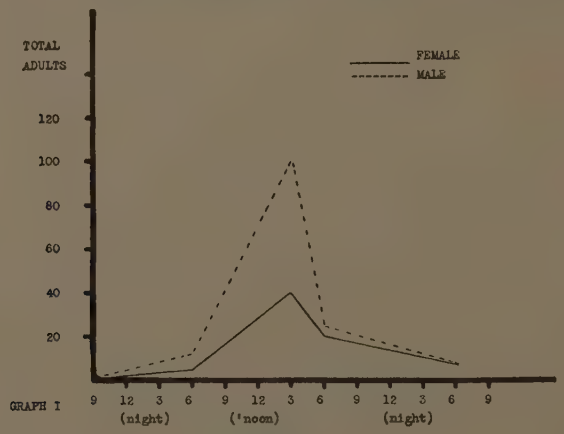

FIG. 1. Emergence of adult mosquitoes from collection number one.

large numbers of fourth instar larvae and pupae were collected and taken to the laboratory for their emergence. Possibly this transfer changed the time when they would have normally emerged and even possibly the sex may have been changed, but records were kept anyway for study. Eight hundred sixty (860) adults emerged in the laboratory.

The larvae and pupae were collected at random along the edge of the sewer and placed in narrow-mouthed litre bottles which were kept in the laboratory where the temperature ranged between seventy and eighty-five degrees Fahrenheit. Erlenmeyer flasks were inverted and placed over the mouths of the bottles. The adults emerged and rose into the flasks where they remained. At regular intervals the flasks were removed and their contents identified.

Bottle Number One: The first larvae and pupae collected emerged as shown in Fig. 1, Graph I within thirty-three hours. The largest number emerged during the hours between ten in the morning and two in the afternoon. The ratio of males over females was approximately two to one at all hours except at six o'clock in the evening.

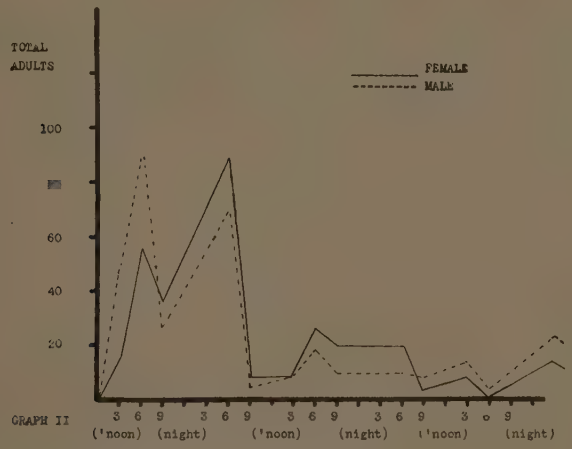

Fig. 2. Emergence of adult mosquitoes from collections, two, three, four and five.

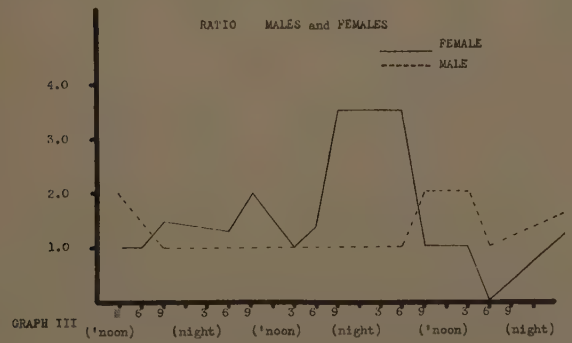

Fig. 3. Ratio of male to female mosquitoes at various times during the day.

Bottles Number Two, Three, Four, and Five: The results of these four were combined because of their similarity. The procedures were identical.

With the exception of the pulsation of adults which occured six hours after the apparatus was set up, most of the adults emerged during the early evening and night (Fig. 2). This was in contrast to the first larvae and pupae collected. Possibly the fact that these first ones were collected early in the morning had something to do with their relative early emergence.

Of particular interest, however, was the ratio of the males and females at various times during the day. As seen by Fig. 3, Graph III there was a tendency for the males to outnumber the females during the day but at night the sexes became equal in number or else the females became more abundant.

Two years later, in Ohio, the author set up a similar apparatus using a five-gallon bottle. Adults were reared from the eggs. *Culex territans* Walker, common in local rain barrels, was used. The results were as shown by Fig. 4.

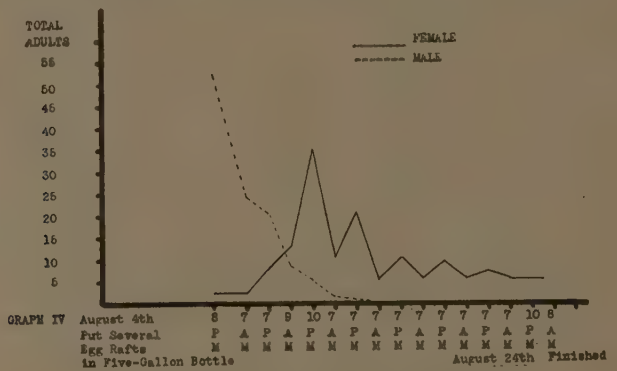

FIG. 4. Emergence of adults of *Culex territans*.

Conclusions based on so little evidence are of little real value but it was extremely interesting to note that males emerged first during the first four days whereas females continued to emerge throughout the entire week. In all, one hundred sixteen males and one hundred twenty-five females emerged.

National Wildlife Federation Announces Nation-Wide $500 Conservation Poster Contest

Again this year the annual national Conservation Poster Contest will be sponsored by the National Wildlife Federation, announced D. C. Gleeson, Director of the Servicing Division. The purpose of the contest is to develop nation-wide interest, particularly among young people, in the need of restoration and conservation of our natural resources.

The Wildlife Poster Contest is open to all students in the United States from the seventh through the twelfth grades in high schools. The contest will be divided into two groups with a separate prize for each. Group No. 1 will cover all contestants in the seventh, eighth, and ninth grades; and the first prize in this category will be $100.00. Group No. 2 will cover the high school grades through the senior year, and the first prize for this group will be $250.00. All entries must be received by January 10, 1950. All awards will be made in connection with National Wildlife Restoration Week, celebrated the first week of Spring in 1950. Other prizes ranging from $100.00 to $10.00 will be presented.

The subject of the poster is: Soil and Water—and Their Products. Entries may be based on a general theme of these basic natural resources and may include Soil Use, Conservation Practices, Forestry, Wild Flowers, Plantlife, Animals, Birds, Fish, Water Resources, Pollution, and Flood Control. A conservation slogan should appear on the poster with no other printed matter.

Last year, over two thousand entries were received from all parts of the United States. The winning poster was drawn by Shirley Kabel, a student of Bennett High School in Buffalo, New York.

Rules of the Wildlife Poster Contest may be obtained by writing to the National Wildlife Federation, Washington, D. C. The poster judges will be announced at a later date.

SUMMARY OF LITERATURE ON NUTRIENT MEDIA USED IN CULTURING LIVERWORTS

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During the course of recent investigations into the growth of liverworts, it was found that the information pertaining to the nutrient solutions, which had been used, was widely scattered and often difficult to find. In the following an attempt has been made to give a brief survey of this material in such a way that the composition of the various media may be compared and evaluated. In several instances when the quantities were not given in grams per liter, this data has been added in parentheses in a third column, for the purpose of conformity and comparison. The arrangement is chronological.

Marchal (1906) reported that he had cultured *Cephalozia byssacea* successfully on the following nutrient solution:

$NH_4(NO_3)$	1.00 g.
K_2SO_4	0.50
$CaSO_4$	0.50
$MgSO_4$	0.50
K_2HPO_4	0.50
$Fe(SO_4)_3$	0.01
Distilled water	1000.00 ml.

Adjusted to pH 7.0 with 10 per cent KOH.

Dachnowski (1907) used Knop's solution modified in concentrations of 0.1 per cent to 0.4 per cent, with 0.3 per cent used most often, for culturing *Marchantia polymorpha* in the study of the development of rhizoids and the formation of gemmae. This was made up of the following:

$MgSO_4$	0.0075 g.
$Ca(NO_3)_2$	0.0300
K_2HPO_4	0.0075
KCl	0.0035
$FeCl_3$	trace
Distilled water	1000.00 ml.

Osterhout (1907) used two nutrient solutions for the culturing of gemmae of *Lunularia* successfully for 200 days,—the duration of the experiment.

NUTRIENT SOLUTION A

	cc. of 3/32 Molar	
NaCl	1000 cc	(5.4803 g.)
$MgCl_2$	78	(0.6964 g.)
$MgSO_4$	38	(0.4288 g.)
KCl	22	(0.1538 g.)
$CaCl_2$	10	(0.1040 g.)
Distilled water		(1000 ml.)

On solution A, which was diluted artificial sea water,[2] there was a 1204 per cent increase in the length of the thallus. Another solution (solution B) which he also used gave almost equal results, a 980 per cent increase in the length of the *Lunularia* thallus.

NUTRIENT SOLUTION B

	cc. of 3/32 Molar	
NaCl	1000 cc	(5.4803 g.)
KCl	22	(0.1538 g.)
$CaCl_2$	10	(0.1040 g.)
Distilled water		(1000 ml.)

[1]I wish to express my appreciation to Dr. Margaret Fulford for much helpful criticism in reading the manuscript.

[2]The artificial sea water was prepared from Van't Hoff's formula which has the same constituents but at ⅔ M. strength.

Killian (1911) reported favorable results using a nutrient solution devised by Marchal for the study of cultures of hepatics. This included the following:

$NH_4(NO_3)$	1.00 g.
$K_2(SO_4)$	0.50
$Mg(SO_4)$	0.50
$Ca(SO_4)$	0.50
$(NH_4)_3PO_4$	0.50
$Fe(SO_4)_3$	0.01
Distilled water	1000.00 ml.

Buch (1920) reported good results with a nutrient solution which he had used in a morphological and physiological study of *Sphenolobus Michauxi*, *Pellia epiphylla*, *Blepharozia ciliaris*, and *Cephalozia bicuspidata*. It contained the following:

K_2HPO_4	0.80 g.
$MgSO_4$	0.30
$CaCl_2$	0.30
$FeCl_3$	trace
Distilled water	1000.00 ml.

For his studies with the protonema of these species, Buch altered his nutrient solution and made a solid medium with the addition of agar as follows:

KNO_3	0.12 per cent	(1.20 g.)
K_2HPO_4	0.08	(0.80 g.)
$MgSO_4$	0.03	(0.30 g.)
$CaCl_2$	0.03	(0.30 g.)
Fe_2Cl_6	trace	(trace)
Agar	2.00	(20.0 g.)
Distilled water		(1000 ml.)

Lilienstern (1927) used both Uspenski's and Detmer's solutions plus two per cent agar for culturing *Marchantia polymorpha* in a morphological and physiological study. The composition of these two nutrient solutions is given below:

Uspenski Nutrient Solution

KNO_3	0.02500 g.
$MgSO_4$	0.02500
$Ca(NO_3)_2$	0.10000
KH_2PO_4	0.02500
K_2CO_3	0.03450
$Fe_2(SO_4)_3$	0.00125
Distilled water	1000.00 ml.

pH of nutrient solution 7.6.

Detmer Nutrient Solution

$Ca(NO_3)_2$	1.00 g.
$MgCl_2$	0.25
$MgSO_4$	0.25
KH_2PO_4	0.25
$FeCl_3$	trace
Distilled water	1000.00 ml.

The pH of the solution 6.8.

Ehring (1934) used the following four solutions on *Marchantia polymorpha*, *Lunularia cruciata*, and *Riccia fluitans* with success.

"a" Nutrient Solution

$NaNO_3$	0.0200 per cent	(0.200 g.)
$CaCl_2 \cdot 6H_2O$	0.0100	(0.100 g.)
$MgSO_4 \cdot 7H_2O$	0.0100	(0.100 g.)
KH_2PO_4	0.0100	(0.100 g.)
$FeSO_4 \cdot 7H_2O$	0.0005	(0.005 g.)
Distilled water		(1000 ml.)

(Approximate salt concentration 0.05 per cent.)

"β" NUTRIENT SOLUTION

KNO_3	0.010 per cent	(0.10 g.)
$CaSO_4 \cdot 2H_2O$	0.020	(0.20 g.)
KH_2PO_4	0.020	(0.20 g.)
$MgSO_4 \cdot 7H_2O$	0.020	(0.20 g.)
Fe_2O_3	0.003	(0.03 g.)
Distilled water		(1000 ml.)

(Approximate salt concentration 0.07 per cent.)

"γ" NUTRIENT SOLUTION

KNO_3	0.1000 per cent	(1.000 g.)
$Ca_3(PO_4)_2$	0.0500	(0.500 g.)
$MgSO_4 \cdot 7H_2O$	0.0500	(0.500 g.)
$FeSO_4 \cdot 7H_2O$	0.0005	(0.005 g.)
Distilled water		(1000 ml.)

(Approximate salt concentration 0.2 per cent.)

"δ" NUTRIENT SOLUTION

NH_4NO_3	0.020 per cent	(0.20 g.)
$Ca_3(PO_4)_2$	0.020	(0.20 g.)
KCl	0.020	(0.20 g.)
$MgSO_4 \cdot 7H_2O$	0.020	(0.20 g.)
$FeSO_4 \cdot 7H_2O$	0.002	(0.02 g.)
Distilled water		(1000 ml.)

(Approximate salt concentration 0.08 per cent.)

Müller (1939) reported a nutrient solution used by Lorbeer which is a nutrient agar modification of the one used by Benecke.

NH_4NO_3	0.200 g.
$CaCl_2$	0.100
KH_2PO_4	0.100
$MgSO_4$	0.100
$FeCl_3 \cdot 3H_2O$	0.005
Agar	15.00
Distilled water	1000.00 ml.

Also in the same year, Griggs (1939) reported a nitrogen free solution on which he had cultured *Cephaloziella byssacea* successfully for three years. The solution was a modification of one of the three salt nutrient solutions devised by Shive, but with only two-fifths the concentration.

KH_2PO_4	1.225 g.
$MgSO_4 \cdot 7H_2O$	1.848
$CaSO_4$ (anhydrous)	0.340
iron as:	
ferric phosphate, or	
ferric chloride, or	
ferric citrate	trace
Distilled water	1000.00 ml.

(The pH of the solution was between 5 and 6.)

Voth and Hamner (1940) used the following nutrient solution successfully in a physiological study of *Marchantia polymorpha*.

$MgSO_4$	0.1204 g.
$MgHPO_4 \cdot 3H_2O$	0.1744
$Mg(NO_3)_2 \cdot 6H_2O$	0.2564
$CaSO_4$	0.1722
$CaH_4(PO_4)_2$	0.1261
$Ca(NO_3)_2$	0.2362
K_2SO_4	0.1742
KH_2PO_4	0.2723
KNO_3	0.2022
Trace elements	1.00 ml.
$MnSO_4$	0.20 p.p.m.
$Na_2B_4O_7$	0.20 p.p.m.
$ZnCl_2$	0.20 p.p.m.
$FeSO_4$	0.02 p.p.m.

(Osmotic concentration approximately 0.285 atmos.)

Since then, we have successfully cultured plants of *Leucolejeunea clypeata*, for five months, on the nutrient solution described by Voth and Hamner above.

Voth (1941) later suggested the following nutrient solution as the one best for culturing *Marchantia polymorpha*.

	cc. of 0.5 Molar	
KNO_3	1.6	(0.0808 g.)
$Ca(NO_3)_2$	1.4	(0.1148 g.)
$Mg(NO_3)_2$	1.2	(0.0890 g.)
KH_2PO_4	0.8	(0.0544 g.)
$MgSO_4$	1.6	(0.0962 g.)
Distilled water		(1000 ml.)

Very recently Prât (1948) has reported cultivation of various hepaticae on the following mineral nutrient agar:

NH_4NO_3	0.200 g.
$CaCl_2$	0.100
KH_2PO_4	0.100
$MgSO_4 \cdot 7H_2O$	0.100
$FeCl_3 \cdot 6H_2O$	0.005
Agar	8.00
Distilled water	1000.00 ml.

Prât also stated that *Riella* was cultured in erlenmeyer flasks on sand to which the above nutrient solution was added, minus the agar.

LITERATURE CITED

Buch, Hans. 1920. Physiologische und experimentell-morphologische Studien an beblätterten Lebermoosen 1–11. Oversikt Finsk. Vetensk. Soc. Forhandl. 62 (Afd. A, Nr. 6): 1–46. 2 taf. 1919–1920.

Dachnowski, A. 1907. Zur Kenntnis der Entwicklungs-Physiologie von *Marchantia polymorpha*. Jahrb. Wissensch. Bot. 44: 254–286.

Ehring, L. 1934. Untersuchengen über die Wirkung des destillierten Wassers und verschiedener Salze auf das Wachstum von Lebermoosen. Inaugural Dissertation. Munster. 1–51.

Griggs, R., and **D. Ready.** 1934. Growth of liverworts from Katmai in nitrogen free media. Amer. Jour. Bot., 21: 265–277.

Killian, C. 1923. Cultures d'Hepatiques. C. R. Soc. Biol. Strasbourg (Paris) 88: 746–748.

Lilienstern, M. 1927. Physiologische-morphologische untersuchung über *Marchantia polymorpha* L. in Reinkultur. Ber. Deutsch. Bot. Ges., 45: 447–453.

Marchal, El. and **Em. Marchal.** 1906. Recherches physiologiques sur l'amidon chez les Bryophytes. Bull. Soc. Roy. Bot. de Belgique. 43: 115–214.

Müller, K. 1939. Rabenhorst's Kryptogamen-Flora. VI. Lebermoose. pp. I–160. Leipzig.

Osterhout, W. 1907. On the importance of physiologically balanced solutions for plants. Parts 1 and 2. Bot. Gaz., 42: 127–134; 44: 259–271.

Prât, S. 1948. Algarum, Hepaticarum, Muscorumque in culturis collectio. Plantarum physiologiae institutum Universitatis Carolinae. Preslia. 22–23: 1–12.

Uspenski, E., and **W. Uspenskaja.** 1925. Reinkultur und ungeschlechtliche Fortpflanzung des *Volvox minor* und *Volvox globator* in einer synthetischen Nährlösung. Zeitschr. Ztschr. f. Bot., 17: 273–308.

Voth, P. 1941. Gemmae cup production in *Marchantia polymorpha* and its response to calcium deficiency and supply of other nutrients. Bot. Gaz., 103: 310–325.

Voth, P., and **K. Hamner.** 1940. Responses of *Marchantia polymorpha* to nutrient supply and photoperiod. Bot. Gaz., 102: 169–205.

REDUCTION OF THE INCIDENCE OF COMPLICATIONS OF PREGNANCY[1]

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It is obvious that it is impossible to perform a controlled experiment dealing with problems affecting human reproduction. In order to arrive at a reasonably accurate incidence of the various complications and abnormalities affecting both the maternal and fetal organism a large number of records must be evaluated. Such a study made with a sufficiently large number of consecutive and carefully analyzed case histories has clinical and statistical significance and should serve as an adequate substitute for a controlled experiment.

The expected incidence of the various complications of pregnancy is known. This report is made from a study of 382 consecutive private patients. Each patient was given a daily dose of wheat germ oil concentrate[2] throughout her entire pregnancy. Our earlier study (4) prompted this prophylactic approach. A significant lowering of the expected incidence of the various complications of pregnancy was observed.

This study shows that 30 patients or 7.8 per cent threatened to abort, and of these 16 or 53.3 per cent of those who threatened to abort went to term, and 14 or 46.6 per cent of those who threatened to abort did abort. The abortion rate of this series is 3.6 per cent. The accepted rate of threatened abortion is between 15 to 25 per cent. The actual spontaneous abortion rate in this country is reported to be at least 13 per cent (1), (2), (3), (5).

Our study also reveals a lowering of the expected incidence of toxemias of pregnancy, prematurity, still-births, and neo-natal deaths. This last condition is due to the higher survival rate among those babies who are born prematurely.

There were no gross abnormalities among either the term or premature babies. Among those who aborted only one embryo showed a gross development deficiency.

We feel that we have used the wheat germ oil concentrate in a sufficiently large number of consecutive patients to justify the belief that the incidence of the complications of pregnancy may be markedly reduced.

PATIENTS STUDIED

Three hundred and eighty-two patients were observed. Each was given three 3 minim capsules of wheat germ oil concentrate daily throughout her entire pregnancy. If complications arose, the dosage was increased.

RESULTS:

THREATENED ABORTION

Of this series of 382 patients, 30— 7.8 per cent threatened to abort. Only 14—3.6 per cent did abort, and 16 or 4.2 per cent were controlled and were delivered at term. No malformed infants were delivered and only one embryo showed a gross development deficiency.

A patient classified as having a threatened abortion exhibited vaginal bleeding with or without cramping. Bleeding from local lesions was excluded and in all patients the blood serology was negative. We made a radical departure from the accepted treatment of threatened abortion. None of the patients was put to

[1]From the Department of Obstetrics, White Cross Hospital.

[2]An 8 to 1 concentrate of wheat germ oil made by removing the glycerides and retaining the unsaponifiable fraction. The wheat germ oil is extracted from fresh wheat germ with ethylene dichloride by the VioBin Corporation, Monticello, Ill.

bed. Each patient was permitted to carry on her usual household duties, and her dosage of wheat germ oil concentrate was increased from three capsules daily to twenty capsules daily. This dosage was continued until all bleeding had ceased for two days and the dosage of the concentrate was then decreased one capsule daily until she was again taking three capsules per day.

RH FACTOR

Fifty patients were Rh negative. Thirty-eight were multigravida and twelve were primigravida. Ten husbands were also Rh negative. Only three of these patients threatened to abort, but all three were controlled and delivered at term. One mother delivered a baby who developed the toxic form of erythroblastosis and died on the eighth day. Her first child was normal but she lost her second child on the third day with the icteric form of erythroblastosis. It is interesting that the anti Rh antibody titer of this mother's blood never exceeded 1 : 64 and dropped to 1 : 32 just before delivery.

Wheat germ oil concentrate may be a factor in the prevention of some cases of erythroblastosis fetalis by lowering the incidence of threatened abortion and thereby preserving the integrity of the syncytial barrier.

PREMATURITY

The standards of the American Academy of Pediatrics were used in the classification of the premature infants. Twelve mothers had fourteen premature babies; there were two sets of twins. Three of these babies were still-born, two due to abruptio placenta, and one due to severe pre-eclampsia in a diabetic mother. The corrected percentage of prematurity in this series was 2.8 per cent.

Class 1—1000 Gms. or less—1. or 7 per cent of prematures.
Class 2—1000–1500 Gms.—1. or 7 per cent of prematures.
Class 3—1501–2000 Gms.—8. or 5.6 per cent of prematures.
Class 4—2001–2500 Gms.—3. or 2.1 per cent of prematures.

Two premature babies succumbed in the neo-natal period. One was a class 2 and the other a class 3 premature. Of the premature babies born alive, 9 survived. The premature survival rate for all classes of premature babies was 82 per cent.

The expected incidence of prematurity as reported by Brown et al. (5) after a study of 13,399 mothers and infants was 7 per cent. Eastman (6) reported the incidence of prematurity in a study of 28,493 deliveries to be 11.7 per cent. An analysis of 32,381 consecutive deliveries in Franklin County, Ohio, showed the incidence of prematurity to be 7.1 per cent.

It has been shown that bleeding in pregnancy doubles the incidence of prematurity (7), (8). Any agent that will aid in the prevention of uterine bleeding must necessarily be an important factor in saving infant lives. Prematurity is the largest single cause of death in the first year of life. It is also the only condition of infants which is listed among the first ten causes of death. The prevention of prematurity is probably more important than good pediatric care.

We believe the figures shown are significant. Our incidence of prematurity of 2.8 per cent (corrected) is lower and the survival rate of 82 per cent is higher than that usually reported.

TOXEMIAS OF PREGNANCY

Nausea and vomiting of pregnancy occurred in 113 patients or 29.5 per cent of the series. This was easily controlled by the intravenous administration of pyridoxine HCL (9). The early correction of nausea and vomiting may have been a factor in the reduction of late toxemias of pregnancy (10). We are unable to determine to what extent the wheat germ oil concentrate was responsible for lowering the incidence of toxemia.

The expected incidence of the pregnancy toxemias exclusive of nausea and vomiting is 10 per cent (11). In this series fourteen (3.4 per cent) patients developed some form of toxemia as shown in the table.

Nephritic Toxemia	(Group A.1) (a)	1 patient	or 0.2 per cent.
Mild pre-eclampsia	(Group B.1) (a)	11 patients	or 2.8 per cent.
Severe pre-eclampsia	(Group B.1) (b)	1 patient	or 0.2 per cent.
Eclampsia	(Group B.2) (a)	1 patient	or 0.2 per cent.

All the mothers survived and one baby was lost, a premature still-born from a non-cooperative diabetic mother.

Evaluation of the toxemias of pregnancy in this series of patients shows a definite reduction over the expected incidence.

STILL-BIRTHS

The incidence of still-births in Franklin County, Ohio, is 2.3 per cent. In our series there were four still-births—an incidence of 1 per cent. There was one avoidable still-birth from a non-cooperative diabetic mother. This baby was also premature. Three still-births were unavoidable—two due to cord accidents and one due to complete abruptio placenta.

DISCUSSION

The use of wheat germ oil concentrate in obstetrics is not new. Currie (12), Watson (13) and Vogt-Moeller (14) have reported on its value. It has been erroneously assumed that the results were due to Vitamin E. Because no one has been able to duplicate the results of these workers by the use of either distilled tocopherols or alpha tocopherol acetate, the clear cut results of Currie and Watson have been discredited.

The results obtained in this series of patients cannot be attributed to the tocopherols since the average American diet is not deficient in tocopherols. There must be a factor or factors other than the tocopherols in wheat germ oil which are of biological significance to the integrity of the reproductive mechanism.

Whatever its mode of action, wheat germ oil concentrate obtained by extraction with chlorinated solvents is of value in the reduction of the incidence of complications of pregnancy.

SUMMARY

Three hundred and eighty-two consecutive obstetric patients were given wheat germ oil concentrate in an attempt to lower the incidence of the complications of pregnancy.

The results of the administration of this substance are given.

1. Thirty patients or 7.8 per cent threatened to abort. Sixteen of these patients were delivered at term and fourteen aborted. In this series the abortion rate was 3.6 per cent.

2. The possibility for Rh incompatibility was present in forty patients or 10.4 per cent. One patient had an erythroblastotic baby which succumbed. No other patient had an increased anti-Rh antibody titer. Rh incompatibility was not responsible for any of the cases of early or late abortion, toxemia, prematurity, or still-births.

3. The corrected incidence of prematurity in this series was 2.8 per cent. The survival rate among the prematures was 82 per cent.

4. The incidence of nausea and vomiting of pregnancy was 29.5 per cent. This was controlled in every patient by the intravenous administration of pyridoxine HCL.

5. Fourteen patients or 3 per cent developed one of the toxemias of pregnancy other than nausea and vomiting. This is one-third of the expected incidence. All of the mothers survived and one baby was lost.

6. The incidence of still-births, avoidable and unavoidable, was 1 per cent.

REFERENCES

(1) **Hudson, G. C.,** and **Rucker, M. P.** Spontaneous Abortion, J. A. M. A., 129: 542, 1945.
(2) Idem.
(3) **Schneider, P. F.** The Management of Threatened Abortion, Surg. Clin. N. Am., 23: 21, 1943.
(4) **Silbernagel, W. M.** Oral Therapy in the Management of Threatened Abortion, O. S. M. J., 43: 739, 1947.
(5) **Brown, E. W., Lyon, R. A.,** and **Anderson, N. A.** Causes of Prematurity; Influence of Uterine Bleeding on the Incidence of Prematurity, A. J. Dis. Child., 71: 428, 1946.
(6) **Eastman, N. J.** Prematurity From the Viewpoint of the Obstetrician, Am. Pract., 1: 343, 1947.
(7) **Brown, E. W., Lyon, R. A.,** and **Anderson, N. A.** Causes of Prematurity—V., Influence of Syphillis on the Incidence of Prematurity, Am. J. Dis. Child., 70: 318, 1945.
(8) Ibid., 71: 428, 1946.
(9) **Silbernagel, W. M.,** and **Burt, O. P.** Effects of Pyridoxine on Nausea and Vomiting of Pregnancy. O. S. M. J., 39: 1113, 1943.
(10) **Missett, J. W.** Relationship Between Early and Late Toxemia of Pregnancy, Am. Obst. & Gynec., 27: 697, 1934.
(11) **Williams, J. W.** Obstetrics, ed. 8, New York, 1941, Appleton-Century Co., p. 623.
(12) **Currie, D.** Vitamin E in the Treatment of Habitual Abortion, Brit. M. Jr., 2: 1218, 1937.
(13) **Watson, E. M.** Clinical Experiences With Wheat Germ Oil (Vitamin E), Can. M. A. J., 34: 134, 1936.
(14) **Vogt-Moeller, P.** Treatment of Habitual Abortion With Wheat Germ Oil (Vitamin E), Lancet, 2: 182, 1931.

The Natural History of Mosquitoes

Mosquitoes occur practically everywhere over the earth and, because of their importance as pests and transmitters of disease, a great deal of literature has been published about them. Scattered through this literature, dealing largely with their classification, control and disease transmission, are numerous observations on their biology. Dr. Bates has assembled in one book data which deal with the natural history of these insects. He has searched carefully and the account is quite complete except for the past several years. What he found was carefully analyzed, appraised, and integrated into this highly informative volume that everyone dealing with mosquitoes will certainly want to read. It only needs to be called to their attention.

This book is uniformly good; each of the twenty chapters contains a wealth of information. Several chapter titles are Food Habits of the Adult, Physiology and Behavior of Larvae and Techniques in Mosquito Study. An excellent feature of the fine bibliography is that each reference is followed by numbers indicating the pages in Bates' book where the reference was used. There are 14 tables, 9 line drawings, and 16 plates consisting of 30 photographs illustrating larval habitats and mosquito techniques. An appendix of mosquito species based on Edward's 1932 list and an index complete the book.—*Carl Venard.*

The Natural History of Mosquitoes, by Marston Bates. xv+379 pages and 16 plates. The Macmillan Co., New York, 1949. Price $5.00.

THREE NEW SPECIES OF CLERIDAE (COLEOPTERA)

JOSEF N. KNULL,
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Phyllobaenus varipunctatus n. sp.

Fig. 1

♀. Robust; light brown, head exclusive of epistoma and mouthparts, outer segments of antennae, all but median and basal area of pronotum, all but median and apical areas of elytra all legs with exception of median areas on middle and posterior femora, middle and posterior tibiae, dark brown; pro- and metasternum and abdomen dark brown.

Head convex, finely, densely punctate, punctures somewhat concealed by light recumbent pubescence; eyes prominent; third segment of antennae much longer than wide.

Pronotum about as long as wide, widest in front of middle, constricted at base and apex; sides rounded in middle, subparallel at base; disk convex with wide subapical transverse depression and a much deeper similar depression at base; surface finely rugose between fine indistinct punctures, densely pubescent with different length hairs. Scutellum small, densely pubescent with light recumbent hairs.

Elytra extending to about middle of abdomen, near base wider than widest part of pronotum; sides converging toward obliquely truncate apices, serrate each side of truncature, dehiscent on inside; disk flattened, apices tumid; surface densely, coarsely punctured to middle, densely finely punctured at middle, rugose from this area to apices, an oblique band of light hairs on each elytron, long brown pubescence dense.

Abdomen beneath moderately densely pubescent. Ungues with a basal tooth.

Length: 4.5 mm.; width 1.4 mm.

Holotype ♀ and paratype labeled Brownsville, Texas, May 25, 1934, J. N. Knull collector, in collection of author.

The color, short elytra and convex pronotum will distinguish this species from other known forms in our fauna.

Phyllobaenus stupkai n. sp.

Fig. 3

Slender, elongate; head, prothorax and scutellum black, elytra with dark brown area extending forward diagonally from near outer apices to suture in front of middle, rest of elytra anteriorly brownish yellow, ventral surface dark brown, mouth parts, antennae and legs brownish yellow.

Head convex, punctures indistinct, pubescence moderate; eyes prominent; third segment of antennae cylindrical, longer than wide.

Pronotum slightly wider than long, widest in front of middle; disk convex, with transverse subapical depression and also transverse depression at base; surface smooth, shining in middle, finely rugose toward sides, irregular, fine punctures sparse, pubescence moderate. Scutellum shining, rounded in rear.

Elytra wider than widest part of pronotum; sides subparallel, dehiscent on inside near apices, side margins serrate from near base to subtruncate apices, which are entire; disk convex, apices slightly tumid; surface opaque, densely, coarsely punctured, densely pubescent.

Abdomen slightly longer than elytra, beneath shining, finely punctured, pubescence moderate. Legs slender, densely pubescent; each unguis with broad basal tooth.

Length: 3.5 mm.; width 1 mm.

Holotype in collection of author, labeled Great Smoky Mountain National Park, Tenn., June 14, 1942, D. J. & J. N. Knull collectors. Named for Mr. Arthur Stupka, park naturalist.

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[1]Contribution from Department of Zoology and Entomology.

Superficially this species resembles *Isohydnocera schusteri* (Lec.), however the shorter pronotum and toothed tarsal claws will separate it. It is same form as *P. chapini* (Wolc.) but less shiny, more pubescent elytra as well as markings will distinguish it.

Isohydnocera chiricahuana n. sp.

Fig. 2

Narrow, elongate; shining, very dark brown with exception of mouth parts, antenna, stripe along lateral margin on each elytron extending from near humerus to near apex, and legs all but area near apex of posterior femora brownish yellow.

Head convex; surface smooth with well separated minute punctures, pubescence short; eyes prominent; antennae with third segment cylindrical, much longer than wide.

1. *Phyllobaenus varipunctatus* n. sp. 2. *Isohydnocera chiricahuana* n. sp.
3. *Phyllobaenus stupkai* n. sp.
(Line = 1 millimeter)

Pronotum cylindrical, longer than wide, widest in front of middle; disk convex, a transverse depression near apex and at base; surface irregularly punctured, punctures larger than those on head, pubescence upright, moderate. Scutellum clothed with light recumbent pubescence.

Elytra at base wider than pronotum, elongate, nearly covering abdomen; sides subparallel, apices separately rounded, serrate; surface convex, densely, coarsely punctured, punctures larger and farther separated toward apices, short upright pubescence intermixed with longer hairs.

Abdomen beneath smooth, moderately pubescent. Femora and tibiae slender, with long pubescence. Ungues without teeth.

Length: 4.5 mm.; width, 1.2 mm.

Holotype and one paratype labeled Chiricahua Mountains, Ariz., Sept. 5, 1947, D. J. & J. N. Knull collectors, in collection of author.

NECROPHILY VS. NECROPHAGY[1]

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"The sanitary officers of the field are legion." (Fabre, 1918).

The aptness of Fabre's statement becomes clearly evident upon examination of carrion found lying exposed in the open field. Scarcely has an animal succumbed before it is attacked by scavenger hordes of necrophilous insects, and in a relatively short interval of time it is reduced to an amorphous mat of bones, integument, and vestitures. Contrary to the opinion a few years past, however, a majority of the coleopterous insects found in association with carrion are not necrophagous. Their presence in and about decomposing flesh is attributable to their predatory habit of feeding on the seething abundance of dipterous larvae and other adult or immature insects for which carrion has attrahent properties.

This paucity of exact knowledge concerning the insects inhabiting carrion is probably due to their lack of any great economic importance. Only a few species have been studied in detail. Members of the family Silphidae have received the most attention, particularly the species of the genus *Necrophorous*. Their peculiar habit of burying small dead animal bodies in crypts where the eggs are laid and the young mature with an assured food supply has attracted a number of observers. The family Staphylinidae has been almost entirely neglected.

The persistent error in entomological literature revolves about a confusion of habits with habitat. In his delimitation of the coleopterous habitats Hatch (1925) used the suffix "bious" to indicate the presence of a species in a particular environs without regard to whether or not it procures food in that environment. Thus, he designated carrion as a necrobious habitat and categorized the families in accordance with the state of the carrion at the time representatives of those families normally appear. The Histeridae, the Staphylinidae, and the Silphidae are found in most abundance around fresh carrion, whereas the Dermestidae and Trogidae are found primarily around dry carrion.

With regard to necrobious forms, at least, the epitaph "short-winged scavengers" is not generally applicable to the Staphylinidae (Voris, 1934). Scavengerism has not been observed in many cases for Staphylinids, nor has the eating of carrion flesh in any stage of decay been determined as a regular occurrence. Actually, most of the coleopterous insects found in carrion environs are not carrion eaters. They are found in a necrobious habitat, hence, are necrophilous. But they are not normally necrophagous.

It has been generally assumed that beetles found in association with carrion are necrophagous, and this concept has been passed along in both general and specific references. The former group includes such widely used texts as Frost (1942), Folsom (1922), Comstock (1940), and Matheson (1944). The latter is exemplified by the works of Jaques (1915) and Herms (1907), who stated that these coleopterous insects were the responsible agents in getting rid of the quantity of naturally decimated fish washed up on lake shores. It seems probable now that the majority of the species they listed are more of a hindrance to the reduction of organic beach debris, since most coleopterous carrion insects actually prey on the necrophagous dipterous larvae found about decay.

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[1]Extracted from material presented to the faculty of the Department of Zoology, North Carolina State College of Agriculture and Engineering, Raleigh, N. C., in partial fulfillment of the degree of Master of Science in Entomology.

FOOD HABITS OF CREOPHILUS MAXILLOSUS (LINNE)

Creophilus maxillosus is conspicuously larger than the majority of beetles found around carrion. It can be distinguished easily from other beetles approximating its size by its Staphylinid characteristic of abbreviated elytra. No other Staphylinids of comparable size are found in such a habitat. Small vertebrate carcasses were employed as lures in obtaining specimens for the following observations.

Creophilus maxillosus characteristically demonstrates entomophagus predatism. Despite its occurrence around carrion, it is not normally necrophagus but preys mainly on the dipterous larvae which mature in decomposing flesh. As stated before, this constitutes a departure from the general concept that coleopterous insects found in association with carrion are strictly carrion eaters.

Captive specimens also accepted live ants, termites, earthworms, and adult flies, and one was observed attempting to pierce the hard exoskeleton of *Trox suberosus*. Just how adept they are at capturing such live prey in the field and how frequently it is attempted was not determined, but evidence seemed to indicate that they might do so whenever such prey was encountered in situations from which escape was not particularly easy. On two occasions adult beetles crawling on the outer surface of a carcass were observed attempting attacks on adult Calliphoridae. In both instances, however, the flies escaped easily by flight. Since the beetles usually enter some aperture of the body and work inside the abdominal or head cavities, it does not seem improbable that they might frequently capture flies entrapped by folds of flesh or viscera in such enclosures.

Flies released in the cages where the beetles were captive generally rested on the sides or top of the cages where they were out of reach and remained unmolested. When they were rendered semi-immobile by a removal of one or both wings and several legs so that they could neither fly nor take refuge on the sides of the cage, they were eventually caught and consumed by the beetles.

The beetles indicated no particular concern over the presence of the flies until they chanced to come across them on the bottom of the cage. When the flies were disturbed by the passing of a beetle, they buzzed noisily and scooted clumsily about on the substratum. The beetles began an immediate attack. They rushed forward and seized the bodies of the flies wherever their mandibles first contacted. Usually they rolled over on their sides or onto their backs and held the flies before them, firmly grasped in their mesothoracic and metathoracic legs. The prothoracic legs were utilized in maneuvering the food toward the mouth parts. The crunching of the exoskeleton was clearly audible when the beetles first punctured their prey and began tearing it apart. Only the soft inner portions were consumed.

The major diet noted in the field as well as in the laboratory consisted of maggots. When the maggots were introduced in the cages of specimens which had not been fed for some time, the beetles became obviously excited and began searching about over the surface of the cage with their antennae quivering rapidly. This suggested a response to an olfactory stimulus. Within a very few minutes the beetles would collect about the supply of maggots and would begin selecting and devouring their prey. Often as many as ten or twelve maggots were eaten in rapid succession.

The adult beetles also demonstrated a remarkable degree of cannibalism. They were quick to pursue and eat the larvae of their own species. The smaller first and second instar larvae attempted escape by burrowing into the loose dirt of the cages, but they seldom succeeded in gaining their freedom. Only the mature third instar larvae, which attained a maximum length of 25 millimeters, were able to ward off the adults with any degree of success. They snapped at the adults ferociously with their mandibles and often discouraged attacks. Sometimes

two beetles would seize the same larva, pulling and tugging at it until it was torn into two portions or until one succeeded in pulling the larva away from its competitor.

All parts of the first two instar larvae were eaten except the head capsules and exoskeletons of the thoraxes. The larger third instar larvae were punctured and the internal contents sucked out.

In addition to consuming the larvae of their own species, the adults attacked one another. They often engaged in fights over the same morsel of food and emerged from such fights with severed antennal segments, tarsi, or entire legs. Such fights or repeated battering against the sides of the cages in escape attempts weakened some of the specimens so that they were no longer able to resist the attacks of their companions. These hapless individuals were pounced upon by one or more of the other adults and dismembered as were the flies. The soft, non-sclerotized portions were eaten. This high degree of cannibalism was also noted by Abbott (1937; 1938).

Although the adults most commonly exhibited predatism and cannibalism, they could also be induced to eat carrion in the absence of their preferred food. If other food was provided, they fed on various dead animals placed in the cages; for example, small fish, lizards, bits of decomposing rabbits and rats, and small pieces of beef. Their liking for such flesh seemed to diminish as the flesh became more decomposed, and they never displayed an immediate enthusiasm for it but only attacked it after a thorough search of the cage yielded food of no other sort. They climbed about over the flesh testing it here and there with their mouth parts before selecting a spot into which they would sink their mandibles. Rau (1922) determined that the specimens he had in captivity preferred raw to cooked meat but would eat cooked meat to sustain life. When bits of flesh infested with maggots were placed in the cages, the beetles consumed the maggots crawling about without attempting to eat the decaying meat. Likewise, adults which were busily consuming carrion would abandon it in preference for dipterous larvae introduced nearby.

Maggots being consumed by the beetles were seized forcefully in their mandibles which were moved pincerlike until the cuticle of the prey was broken or punctured. While feeding, the beetles stood on their mesothoracic and metathoracic legs, using their prothoracic legs to help hold the maggot and to feed it through the mouth parts. Once the cuticle was ruptured, the maggot was fed back and forth through the mandibles and maxillae, which squeezed and mashed it until all the soft parts were extracted and nothing remained but the exoskeletal portions. If the beetle was a particularly small specimen or the maggot large and vigorous, the position assumed was often like that attained in the struggles with flies; that is, the beetle would roll over on its side or on its back holding the maggot before it. In such a position, the prey could not get traction on the substratum, and its struggling was in vain.

Examination of the feeding process under a binocular microscope revealed that the beetles secreted a brownish fluid on their food, and portions of exposed flesh on which the beetles had been feeding became discolored and contrasted from their surroundings. This suggested an extra-intestinal digestion such as Pukowski (1933) reported for species of *Necrophorous* and a means of partially breaking down the food before ingestion.

OBSERVATIONS ON OTHER SPECIES

Clark (1895) recognized that there could be a categorical classification of carrion inhabiting beetles with regard to their food habits and that some species are almost wholly concerned with dipterous larvae encountered in carrion invirons. For example, he classified *Creophilus maxillosus* as primarily a feeder on dipterous

larvae. Various other observations on carrion species in general have supported this early report. Selous (1911) observed that a number of the so-called carrion beetles are not strictly necrophagous at all. Davis (1915) noted the species *Silpha surinamensis* and *Creophilus villosus* consuming fly maggots at a dead porcupine carcass. Steele (1927) tested a number of species in the genera *Silpha* and *Necrophorous* of the family Silphidae to determine their food preferences. From his laboratory experiments he determined a decided preference for dipterous larvae. Other investigators have supplemented and further verified these observations on the Silphidae. Excellent summaries of these have been presented by Voris (1934) and Balduf (1935).

SUMMARY

Necrophily is often confused with necrophagy, and many reports indicate that the majority of coleopterous insects found in association with carrion are predatory, feeding on the dipterous larvae common to carrion, and that slightly decomposed carrion is preferred to that which is strongly decomposed. *Creophilus maxillosus* demonstrates a high degree of cannibalism, attacking and devouring both mature and immature forms. Similar observations have been made on a number of species in the family Silphidae.

LITERATURE CITED

Abbott, Cyril E. 1937. The necrophilous habit in Coleoptera. Bul. Brooklyn Ent. Soc. 32: 202–204.

Abbott, Cyril E. 1938. The development and general biology of *Creophilus villosus* Grav. Jour. N. Y. Ent. Soc. 46 (1): 49–52; pl. I.

Balduf, Walter V. 1935. The bionomics of entomophagous Coleoptera. John S. Swift and Company, St. Louis, Missouri: 1–220; figs. 1–108.

Clark, Charles U. 1895. On the food habits of certain dung and carrion beetles. Jour. N. Y. Ent. Soc. 3: 61.

Comstock, John Henry. 1940. An introduction to entomology. Comstock Publishing Company (9th edition revised): 1–1064; figs. 1–1228.

Davis, William T. 1915. *Silpha surinamensis* and *Creophilus villosus* as predacious insects. Jour. N. Y. Ent. Soc. 23 (2): 150–151.

Fabre, Jean Henri. 1918. The wonders of instinct. Century Company, New York, New York. 1–322.

Folsom, J. W. 1922. Entomology with special reference to its ecological aspects. P. Blakiston's Son and Company, Philadelphia: 1–605; pl. I–V; figs. 1–308.

Frost, S. W. 1942. General entomology. McGraw-Hill Book Company: 1–524; figs. 1–406.

Hatch, M. H. 1925. Habitats of Coleoptera. Jour. N. Y. Ent. Soc. 33: 217–233.

Herms, W. B. 1907. Ecological and experimental study of Sarcophagidae with relation to lake debris. Jour. Exptl. Zool. 4: 45–83.

Jaques, H. E. 1915. The fish feeding Coleoptera of Cedarpoint. Ohio Naturalist 15: 525–528.

Matheson, Robert. 1944. Entomology. Comstock Publishing Company: 1–600; figs. 1–500.

Pukowski, Erna. 1933. Ökologische untersuchungen an *Necrophorous* F. Zietschr. Morph. Okol. Tiere 27 (3): 518–586; figs. 1–25.

Rau, Phil. 1922. Ecological and behavior notes on Missouri insects. Trans. Acad. Sci. St. Louis 24: 1–71.

Selous, C. F. 1911. So-called carrion-feeding beetles often not carrion beetles. Ent. News 22: 324.

Voris, Ralph. 1934. Biologic investigations on the Staphylinidae. Trans. Acad. Sci. St. Louis 28: 233–261.

NOTES ON THE GENUS BRADYTUS STEPH. AND DESCRIPTIONS OF THREE NEW SPECIES (CARABIDAE, COLEOPTERA)[1]

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In the treatment of the Tribe *Amarini* by Csiki ('30) the genera *Feronalius* Casey, *Curtonotus* Steph., *Stereocerus* Kirby, *Leironotus* Ganglb., *Leiocnemus* Zimm., *Bradytus* Steph., *Percosia* Zimm., *Celia* Zimm., and *Triaena* Leconte of the Leng Catalogue are reduced to subgenera of *Amara* Bon. All of these are rather well-defined groups of species and easily separated from each other. It would seem simpler to retain them as genera in dealing with our Nearctic fauna The prothorax wider at the middle than at the base, the comparatively short oval body, the pubescence of the hind tibiae, the prosternal punctured areas and the structure and color of the antennae considered together will separate any species of *Bradytus* from species of other genera that show superficial similarities. No one of the listed characteristics is sufficient in itself to place all species in the proper genus and too great dependence on any one characteristic will lead to misidentification. For example there are two species that have no coarse pubescence on the hind tibiae of the males. There are several species that have no punctured area on the prosternum of the males and in several the prothorax is only slightly wider at the middle than at the base. However when all are considered together there is no question as to placement in the correct genus.

Hayward ('08) lists only six species of the genus. Casey ('18) discusses sixteen species and divides the genus into four groups. Group I (*exaratus*) with four species, Group II (*apricarius*) with one species and Group III (*glacialis*) with three species are adequately treated in Casey's paper and need no further consideration here. Group IV (*latior*) in which Casey placed nine species has been enlarged by the description of three new species by Casey ('24) and by three species that will be described in the pages that follow. Perhaps a key to the fifteen species of the *latior* group will be helpful in recognizing these species. Such a key is difficult to express in brief form because of the close similarities and duplication of structures in this group. A detailed tabulation of the characteristics given in the original descriptions indicates that the species are distinct. All but two of the species have been recognized in collections made in the areas from which they were originally described. *B. relictus* Casey and *B. aequalis* Casey, not yet so found, also seem to be good species as judged by the tabulation. *B. oregonus* Lec., now placed as a synonym of *B. latior* Kby., may be distinct, but since it has not been recognized in western collections and since the original descriptions are very brief and non-committal in certain important respects, it is left as a synonym for the present. *B. aequalis* Casey from Chihuahua, Mexico has been included for comparison and may possibly be found north of the border. A table of all species of Nearctic *Bradytus* and a key to the *latior* group follow.

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[1]Paper No. 44 from the Department of Zoology, Ohio University, Athens, Ohio.

TABLE OF THE NEARCTIC SPECIES OF THE GENUS BRADYTUS STEPH.

GROUP I—*exaartus* group
- *B. gravidus* Casey 18–236
- *B. curtus* Casey 18–236
- *B. exaratus* Dejean 28–509
  - =*furtivus* (Say) 34–429
- *B. stygialis* Casey 18–237

GROUP II—*apricarius* group
- *B. apricarius* (Payk.) 90–125

GROUP III—*glacialis* group
- *B. nainensis* Casey 18–238
- *B. glacialis* Mann. 53–135
- *B. putzeysi* Horn 75–129

GROUP IV—*latior* group
- *B. schwarzi* Hayw. '08–42
  - =*septentrionalis* Lec. 48–358
- *B. latior* Kby. 37–36
  - =*hyperborea* Lec. 48–357
  - *laevistriatus* Putz. 66–262
  - =*liber* Lec. 55–349
  - =? *oregonus* Lec. 55–349

GROUP IV—(Continued)
- *B. humphreysi* Csy. 18–240
- *B. deceptus* Csy. 18–241
- *B. specularis* Csy. 18–241
- *B. spaldingi* Csy. 24–48
- *B. relictus* Csy. 18–242
- *B. obsolescens* Csy. 18–242
- *B. maxwellianus* Csiki 1930
  - =*B. maxwelli* Csy. 24–49
- *B. vegasensis* n. sp.
- *B. novellus* n. sp.
- *B. neomexicanus* Csy. 24–48
- *B. celianus* n. sp.
- *B. aequalis* Csy. 18–242 (Mexico)
- *B. immundus* Csy. 18–243

KEY TO THE LATIOR GROUP OF THE GENUS BRADYTUS STEPH.

1a. Scutellar stria with an ocellate puncture ..... *immundus* Csy.
1b. Scutellar stria without an ocellate puncture 2
2a. Body narrow and elongate, width approx. 3 mm ..... *schwarzi* Hayw.
2b. Body shorter and stouter, width over 3 mm 3
3a. An obtuse carina at the posterior thoracic angles 4
3b. No carina at the posterior thoracic angles 6
4a. Elytral striae fine and very finely punctate, lateral series of ocellate punctures narrowly interrupted ..... *deceptus* Csy.
4b. Elytral striae strong, impressed and moderately coarsely punctate, lateral series of ocellate punctures widely interrupted 5
5a. Head three-fifths as wide as the thorax. Prothorax two-fifths (male) and one-half (female) wider than long. Black and highly polished ..... *latior* Kby.
5b. Head less than three-fifths as wide as the prothorax. Prothorax one-half wider than long in both sexes. Piceous black ..... *humphreysi* Csy.
6a. With an elongate patch of coarse pubescence on the inner side of the hind tibiae of the male 7
6b. Posterior tibiae of the male without such pubescence 14
7a. No scutellar stria; no punctured area on prosternum of the male 8
7b. Scutellar stria and punctured area on prosternum of male present 9
8a. Prosternal process between the coxae and the area between the gular sutures of the head distinctly sulcate ..... *novellus* n. sp.
8b. Prosternal process and gula not at all sulcate ..... *vegasensis* n. sp.
9a. Size 9 mm. and over. Inner basal foveae of thorax small, oval and deep with a few punctures; the outer foveae deep, oblique and impunctate ..... *maxwellianus* Csiki
9b. Size less than 8 mm., basal prothoracic foveae not as above 10
10a. Scutellar stria fine and fragmented; prothorax impunctate dorsally ..... *neomexicanus* Csy.
10b. Scutellar stria entire, moderate to long. Prothorax punctured at least in the basal foveae 11
11a. Prothorax sparsely punctured apically and basally ..... *relictus* Csy.
11b. Prothorax punctured basally only 12
12a. Prothorax sparsely, finely punctate between the basal foveae; scutellar stria long and free ..... *specularis* Csy.
12b. Prothorax punctured in the basal foveae only; scutellar stria moderate 13
13a. Elytral surface finely micro-reticulate, antennae much shorter than the head and thorax ..... *obsolescens* Csy.
13b. Elytral surface polished black, antennae almost reaching the base of the thorax, *spaldingi* Csy.
14a. Basal foveae of the prothorax strongly impressed and closely, strongly punctate; elytral striae deep and punctate to behind the middle ..... *celianus* n. sp.
14b. Basal foveae of the prothorax shallow and sparsely punctate; elytral striae impressed but without obvious punctures ..... *aequalis* Csy.

Bradytus novellus n. sp.

This insect is oblong-oval in shape and dark piceous black above. The under surface is polished dark ferrugineous and the legs, palps, and antennae are entirely ferrugineous. The mandibles are moderately striate on the inner portion of the upper surface; the setae on the margin of the labrum are very long; the frontal strioles are short, deep and oblique; and the antennae are about the length of the head and thorax. The thorax is very convex, slightly wider at the middle than at the base and completely without punctures. The anterior and posterior impressions are obsolete and the median stria is very fine, abbreviated anteriorly but reaching the base posteriorly. The anterior margin is shallowly arcuately excavate and the anterior angles are bluntly rounded and not prominent. The posterior angles are a little more than right, blunt but not rounded. The posterior foveae are deep and impunctate, the inner foveae are linear and nearly reach the base and the external foveae are oblique. The base is margined, obsoletely so medially. The elytral striae are fine but rather deep and impunctate with the seventh stria somewhat shallower than the rest. The scutellar stria is lacking. The intervals are slightly convex, more noticeably near the apex. The under surface of the body is impunctate except for a very few obsolete punctures on the anterior part of the meso-sternum. The prosternal process has a short sulcus between the coxae and there is a short well-impressed sulcus between the gular sutures on the under side of the head. There is no punctured area on the prosternum of the male. The male front tarsi are dilated as usual in the genus and the hind tibiae have the normal coarse pubescent area on the inner surface.

Length: 6.75 to 7.5 mm.

Holotype: Male; Davis Mts., (Ft. Davis), Texas; 9/VII/1911 J. W. Green, Coll.

Allotype: Female; same data.

Paratypes: 11 males, 7 females; same data.

I am indebted to Mr. J. W. Green of Easton, Pa. for turning this series of specimens to me for description. 7 male and 5 female paratypes are in his possession and the remainder in the collection of the author at present.

Bradytus vegasensis n. sp.

The body is convex oblong-oval and polished black above and beneath. The head is a little over half the width of the thorax, very smooth and impunctate. It has shallow linear strioles, eyes moderately convex and antennae and palps ferrugineous throughout. The thorax is five-sevenths as long as wide, very convex, widest at about the middle and narrowed very little posteriorly. The anterior margin is rather deeply arcuately excavate with the anterior angles bluntly rounded and more prominent than in most other species of the genus. The sides are finely and evenly margined and the posterior margin is transverse with the marginal bead interrupted medially. The anterior and posterior transverse impressions are obsolete, the median stria is very fine and abbreviated at both ends, and there is no trace of a carina near the posterior angles. The foveae are small, shallow and impunctate; the inner, linear and not reaching the base; the outer, short and oblique. The entire thorax is very convex and without trace of punctures on the upper surface. The prosternum is smooth and without the punctured area commonly found on males in this genus. The legs are dark ferrugineous throughout and the front tarsi of the males are dilated moderately as is usual. The inner sides of the hind tibiae of the male have the normal coarse pubescence. The elytra are convex, slightly wider than the thorax, with narrow reflexed margins and a short distinct sinus. The stria are complete, distinct, very fine and completely impunctate. The scutellar stria is absent and the lateral series of ocellate punctures is very narrowly interrupted. The under surface of the body is impunctate except for a few obsolete punctures on the anterior half of the meso-sternum.

Length: 7. to 7.5 mm.

Holotype: Male; 6 mi. N. E. of Las Vegas, New Mexico; 18/V/1946. H. F. Strohecker, Coll.

Female unknown.

Paratypes: 2 Males; same data.

The author is indebted to Dr. H. F. Strohecker of the University of Miami, Coral Gables, Fla. for these specimens. One paratype is in the collection of Dr. Strohecker, the others, in possession of the author.

Bradytus celianus n. sp.

The body is oblong-oval, not strongly inflated, polished black above and beneath except that the posterior end of the abdomen and all the legs are rufous. The head, exclusive of the eyes, is slightly over one-half the width of the thorax. The eyes are prominent, the frontal strioles are fine, deep and linear. The entire antennae are rufous and extend slightly beyond the posterior margin of the thorax. The prothorax is five-sevenths as long as wide, widest at the middle, with the sides evenly arcuate and finely reflexed from apex to base. The basal angles are slightly greater than right, not rounded and not carinate. The apical margin of the prothorax is evenly arcuately excavate, five-sevenths as wide as the transverse margined base, and the anterior angles are very blunt and rounded. Both transverse impressions are obsolete; the apical incised line is broadly interrupted at the middle; the median stria is fine and abbreviated anteriorly; and the entire surface is convex, smooth and impunctate except for the basal foveae which are quite deeply impressed and rather closely and deeply punctate. Both foveae are rather broad and very similar in size and shape. The space between the outer foveae and the margins is very convex and the area between the inner foveae is impunctate. The elytra are slightly wider than the thorax and convex. Strial punctures are evident in the anterior half of the first six striae but become obsolete in the posterior half and are missing altogether in the seventh stria. The scutellar stria is moderate in length and is punctate. The lateral series of ocellate punctures is moderately widely interrupted. The intervals are slightly convex on the disk and become strongly so near the apex. The prosternum of the male has a small unimpressed oval area with a few very conspicuous punctures, the pro-episterna are impunctate, the mes-episterna are sparsely shallowly punctured, and the met-episterna are very obsoletely punctate. The front tarsi of the male are moderately dilated and the posterior tibiae of the male are devoid of pubescence on the inner surface. This latter trait allies this species with **B. aequalis** Casey from which it is very distinct in many other respects, however.

Length: 7.5 mm.

Holotype: Male; Jemez Mts., New Mexico, III/20. Jno. Woodgate, Collector.

Female unknown.

This specimen was sent by Mr. J. W. Green of Easton, Pa. who recognized it as unusual. The type is at present in the author's possession.

BIBLIOGRAPHY

Casey, Thomas L. 1918. Memoirs of the Coleoptera, VIII: 234–243. Lancaster, Pa.
1924. *Ibid.*, XI: 48–49.
Csiki, E. 1930. In Junk, Col. Cat. pars 112, Amarini.
Dejean, Comte Pierre F. M. A. 1828. Spécies Général des Colèoptéres de la collection de M. le Comte Dejean. III: Paris.
Hayward, Roland. 1908. Studies in *Amara*. Trans. Am. Ent. Soc. XXXIV: 13–65.
Horn, Dr. George H. 1875. Syn. notes and descriptions of N. Am. Coleoptera. Trans. Am. Ent. Soc., V: 126–156.
Kirby, William. 1837. The insects, in Richardson's Fauna Boreali-Americana IV. London, 325 pp., 8 pl.
Leconte, Dr. John L. 1848. A descriptive catalogue of the Geodaphagous Coleoptera. Ann. Lyc. Nat. Hist., N. Y., IV: 173–474.
1855. Notes on the *Amarae* of the U. S. Proc. Acad. Nat. Sci., Phila. VII: 346–356.
Mannerheim, Graf Carl G. von. 1853. Dritter Nachtrag z. Käfer der Aleutischen Inseln, etc. Bull. Moscou, XXVI: 95–273.
Paykull, Gustaf von. 1790. Mono. Caraborum Sueciae. Upsala.
Putzeys, Jules A. A. H. 1866. Mem. Soc. Sci. Liege, 262.
Say, Thomas. 1834. Descriptions of new species of N. Am. insects. Trans. Am. Phil. Soc. IV: 409–470.